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NEW TECHNIQUES AT THE FERROUS METALLURGY PLANTS OF THE RUSSIAN SOVIET FEDERATED SOCIALIST REPUBLIC (RSFSR) IN 1961

N. I. Sheftel', Gosplan, RSFSR

Translated from Metallurg, No. 5,
pp. 1-2, May, 1961

The rapid industrial development and technical progress of the national economy require a vast increase in metal production, refinement of the grades available, and improvement of the quality of the finished manufacture.

In 1961, together with the construction of large-scale, high-capacity plants highly mechanized and automated, producing plants will be reconstructed on the basis of new techniques, and progressive technological processes allowing an improvement of the technical-economic characteristics of production will be introduced.

At present, one of the specific features in the development of ferrous metallurgy is the construction of large-scale smelting and refining furnaces. This year the largest blast furnaces in Europe will go into operation at the Cherepovets, Novolipetsk, and Novo-Tul'ski plants.

In the Nizhni Tagil combine and at the Novo-Tul'ski plant, it is anticipated that the capacity of the blast furnaces will be increased during the overhauls.

Increasing the useful volume of the furnaces reduces the unit expenditure for construction and decreases the cost of iron by lowering production expenses. Under similar conditions, increasing the volume of the old furnace is 20-30% cheaper than constructing new ones.

In order to improve the performance of the blast furnaces, it is planned to increase the use of fluxed sinter of increased basicity with the exclusion of raw limestone from the burden, to raise the top pressure of the gases, and to increase the temperature of the blast. For example, at the Cherepovets plant the world's best CO_2/CO ratio, 0.577, with a coke consumption of 586 kg/ton of iron was attained in 1960 by completely excluding raw limestone from the burden and operating with a top pressure up to 1.8 atm.

In order to intensify the smelting process, natural gas is to be used in several of the blast furnaces of the Magnitogorsk Metallurgical Combine, at the Kosogorsk plant, the Novolipetsk plant, and at "Svobodnyi Sokol". The effectiveness of using natural gas in smelting is appreciably increased by enriching the blast with oxygen.

In the steel refining industry, superpower open-hearth furnaces and large-capacity electric furnaces are to be put into operation.

At Serp i Molot Plant, oxygen is used in 92% of the total heats, at Chelyabinsk–in 90%, at the "Élektrostal'" Plant –in 65%, and in the Nizhni Tagil combine–in 56%.

In comparison with other types of metallurgical fuels, natural gas has a higher calorific power and fewer harmful impurities. By operating with natural gas, the productivity of open-hearth furnaces is appreciably increased, and expenditures for fuel are reduced. In the ferrous metallurgy plants of the RSFSR, 50 open-hearth furnaces are already operating on natural gas. It is planned that approximately 9 million tons of steel will be refined using natural gas in the Magnitogorsk Metallurgical Combine and at the "Krasnyi Oktyabr' ", Taganrog, and "Serp i Molot" Plants in 1961.

By switching to the use of high-calorific natural gas in the open-hearth furnaces, the necessity of preheating the gas in the regenerators is eliminated, and the construction of the furnaces is simplified. Expenditures for construction are also reduced thereby.

Complex automation of the thermal regime of the open-hearth furnace is a large potential source of enlarging a steel heat. In the Nizhni Tagil Metallurgical Combine, the contract of steel rose from 11.7 to 13.3 tons/m^2

and in a single 24 hour period to 16 tons/m² with a decrease in ideal fuel consumption by 5.5% due to the automation of the 370-ton open-hearth furnace.

This year at the Zlatoust Metallurgical Plant, thousands of tons of metal will be refined using synthetic slags with the aim of improving the quality of the metal. This type of refining allows the time required for a heat to be reduced, inasmuch as deoxidation and desulfurization take place in the ladle directly as the steel is tapped.

Maintaining a vacuum in the ladle allows less gas impregnation of the metal and reduces the quantity of solid nonmetallic impurities. It has been confirmed by operations conducted at a number of plants that a high degree of evacuation improves the magnetic properties of transformer steel, increases the purity of ball bearing steel, and improves the surface quality of rolled stock from a series of constructional steels.

At a number of plants, it is the plan of new practices to subject not less than 50 thousand tons of steel to vacuum processing during casting. There is to be a wider use of electrically heating the head of the ingots of alloys and high-alloy steels, permitting a considerable decrease in the size of the shrinkage pipe.

The technical progress in industry and the development of new branches of engineering dictate the necessity of increasing the manufacture of steel of higher purity and with special physical and mechanical properties. In this regard, there will be a considerable increase in the capacities for vacuum melting, for remelting alloys and steel in electric-arc furnaces with consumable electrodes, and of the installations for electric-slag refining (at the Zlatoust, "Élektrostal'" Chelyabinsk, and Izhevsk plants).

The high quality of the metal obtained in electric-slag refining is explained by the effective working of the liquid metal under the basic, high-temperature slag and the controlled crystallization of the ingot in the crystallizer. The separation of gases and nonmetallic impurities from the metal during the process and the even dispersion of structural components increase the ductility of the steel, improve its weldability, and decrease the anisotropy of its mechanical properties. The macrostructure of this metal is characterized by high density, homogeneity, the absence of defects from shrinking and liquefying processes and marked paucity of nonmetallic impurities.

In the decisions of a coordination conference for the electric-slag refining of metal, it is recommended that this method be used for the manufacture of ball bearing steel, the stainless steels 0Kh18N9, ÉI736, ÉI847, ÉI851, ÉI961, and also for construction steels 12Kh2N4A, 18KhNVA, 40KhNVA.

This year not less than 625 thousand tons of steel of various types will be cast at continuous-casting installations; this steel includes transformer, stainless, alloy, high-carbon, and also rimmed types.

A considerable increase in rolling and tube-rolling production is also anticipated. The first line of a cold-rolling mill at the Cherepovets plant, the second line of a cold-rolling mill at the Novolipetsk plant, and mills for producing cold-rolled strip at the Magnitogorsk and Minyar plants will be put into operation this year; at the Cherepovets plant the largest small-section, double-thread, continuous, 250 mm mill in the RSFSR will begin operation; with the starting of the sheet-rolling mill at the Chelyabinsk plant, the output of stainless-steel sheet will be considerably increased.

In order to satisfy the demands of the national economy for precision alloys during the current year, the capacities for producing these alloys will be increased at the "Élektrostal'", Leningrad steel-rolling, and Izhevsk plants; work on a roll method of producing these alloys with the rolling of slabs from the "Élektrostal'" plant in a semicontinuous mill at the Novosibirsk Metallurgical Plant will be intensified.

At the new tube mill in Pervoural'sk a continuous mill for rolling seamless pipe with an external diameter of 30-102 mm and walls upward from 2.5 mm thick will go into operation. The pipe from this mill will partially replace cold-rolled pipe, and this will permit the output of drawn pipe at the active drawing mills to be increased. A great deal of work on automation and mechanization is to be done at both the rolling and tube-rolling mills.

In order to decrease the volume of labor-consuming adjustment work, flame trimming (in the presence of oxygen) is to be used in the Magnitogorsk Metallurgical Combine and in the blooming mill at the Cherepovets plant. It is anticipated that on the new machines a layer of metal 1.5-2.5 mm in thickness will be removed.

With the starting of the second line of the cold rolling mill with tower furnaces at the Novolipetsk plant, it will be possible to increase the output of cold-rolled transformer steel two-three times, to improve its magnetic properties by decarburization treatment, and arrange for the production of cold-rolled transformer-steel coil. In the Magnitogorsk Metallurgical Combine the production of electrolytic tin plate and the galvanization of sheet in coils will be arranged, providing a large saving in tin and zinc and increased labor productivity.

At the Nytva Metallurgical Plant the production of rolled sheet having one or both sides coated with non-ferrous metals will be increased. At all qualitative metallurgical plants a considerable increase in the output of sectioned strip is planned in order to prepare a process for bending and welding ring blanks of stainless steel which, in comparison with the production of ring blanks on a fuller at tire mills, will permit metal waste to be decreased several times.

In the Nizhni Tagil Metallurgical Combine the rail-finishing mill will be reconstructed to produce rails 25 m in length, and also an experimental batch of chrome-vanadium rails for curved tracks of small radius is to be prepared.

Included in the application of the new techniques are extension of the work on the welding of pipe using radio-frequency current (Moscow Pipe Plant), manufacture of pipe which is lined with plastic and enamel on the inside, and organizing of the manufacture of pipes by the induction-welding method on the production line at the Novosibirsk Metallurgical Plant.

It is planned that on the conveyer lines of the plant "Svobodnyi Sokol", the casting of water pipes 200-300 mm in diameter and 6 m long will be arranged. At the Izhevsk Metallurgical Plant hot-drawing of high-speed steel for the manufacture of silver steel is being done. This process will also be widely used at other plants this year. In two of the cold-rolling mills at the new tube plant in Pervoural'sk a "warm rolling" of pipe is being adopted.

The introduction of contact electric heating for annealing the thinnest Nichrome wire is anticipated at the Beloretsk Steel Wire Plant. At the Taganrog Metallurgical Plant high-frequency currents will be used for the heat treatment of high-resistant drill and casing pipes.

A considerable metal saving for the national economy may be realized by the use of sheet steel after a heat treatment which improves its strength characteristics and permits the use of rimmed instead of killed steels and carbon instead of alloy steels in many instances. In 1961 heat-treating departments will be put into operation at the Cherepovets plant and in the Orsk-Khalilovo combine. When these departments go into operation, the manufacture of heat-capacity facilities will begin.

Fulfilling the task of introducing new techniques and progressive technology will ensure further growth and rise of the technical level of ferrous metallurgy and will increase the supply of metal in the national economy.

THE UTILIZATION OF FUEL OIL IN BLAST-FURNACE PRODUCTION

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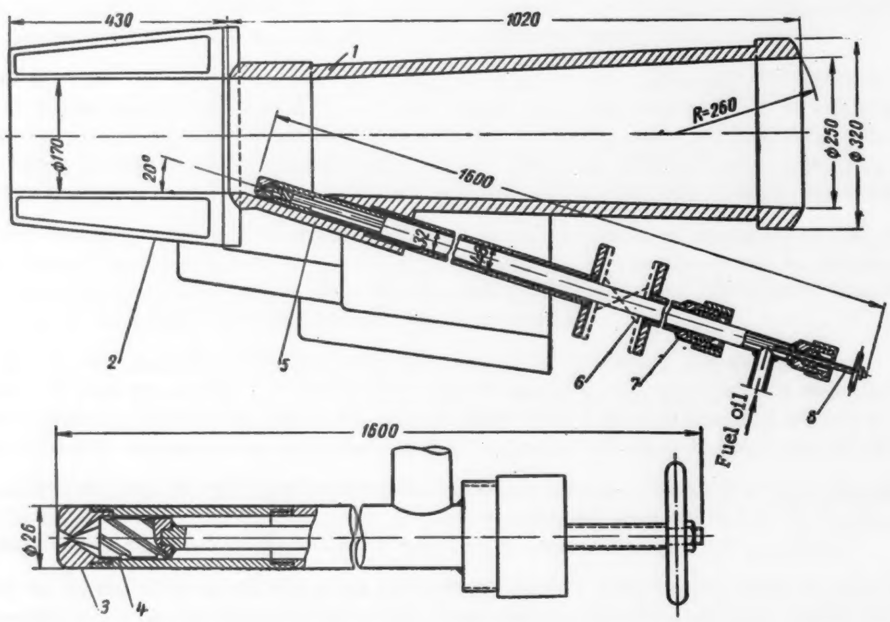
The reduction of coke consumption is one of the basic problems in blast-furnace production. A good prospect in this regard is, for example, the utilization of fuel oil in the blast furnaces. It costs appreciably less than coke. In plants located in the principal oil-producing regions, the cost price of fuel oil is not even considered ; it is obtained for approximately one ruble per ton. From thermotechnical and aerodynamical considerations, blowing fuel oil into the combustion zone is no less effective than blowing in natural gas . It may be seen from Table 1,* where the data from the combustion of various fuels is given, that the temperature obtained in burning fuel oil is higher than in burning natural gas or other gaseous fuels and that the volume of combustion products per unit of heat evolved is less.

When fuel oil and natural gas are burned in the blast furnace in calorifically equivalent quantities, fuel oil provides a greater saving in coke and less increase in the output of waste gas with a relatively small decrease in the temperature of the furnace gas.

The utilization of fuel oil in the blast furnace has been repeatedly attempted both here and abroad. These attempts, however, have only been transitory experiments. Apparently, one of the basic reasons for the lack of success in using fuel oil has been the failure to work out a satisfactory method for feeding it into the furnace.



Nozzle with fuel-oil sprayer. 1) Nozzle; 2) tuyere; 3) sprayer cap; 4) spiral three -way insert; 5) sprayer housing; 6) shut-off valve; 7) collar; 8) regulating rod.

* Table 1 will be found on p. 208 [Publisher's note].

According to the data from the performance tests described below at the Chusov plant, fuel oil can be efficiently fed through the tuyeres; however, a number of conditions must be met:

1) The fuel oil must be prevented from striking the walls of the tuyeres and depositing oil residue on them;

2) sufficient atomization of the fuel oil in the narrow conditions of the tuyeres must be provided;

3) the use of any sort of atomizer to avoid lowering the temperature at the tuyeres is undesirable;

4) observation of the inflow of fuel oil and furnace operation through inspection ports on the tuyeres is to be provided for;

5) clogging of the jets with residue during operation with a blast preheated to 800-1200° must be avoided;

6) ignition of the fuel oil inside the tuyeres must be prevented, since this leads to excessive overheating of the jets and tuyeres.

Cold tests conducted on a natural size model of the tuyeres showed that when liquid (water) is fed laterally into an air stream having a velocity equal to that of the blast in the nozzles of the blast furnace, the atomized stream assumes a form which precludes the liquid striking the walls of the air nozzle over a comparatively large fraction of its length. A thin mixture of air and liquid issues from the nozzle; preliminary atomization of the liquid is, moreover, unnecessary.

On the basis of the experimental results and experience with the operation of various devices on liquid fuel, an apparatus was designed for feeding fuel oil into the blast furnace. This consists of a power-driven sprayer provided with a spiral insert (swirler) and pivot for regulating the input of fuel oil and cleaning the exit orifice without removing the sprayer (see figure).

Sprayers of the proposed design were installed on one of the blast furnaces of the Chusov Metallurgical Plant. Practice has shown that for uninterrupted feeding of fuel oil into the furnace, the pressure at the sprayers must not be higher than 2 atm.

The performance of the blast furnace with continuous injection of fuel oil over a month's period during the investigations,followed by adopting the feeding apparatus into continuous service, has fully demonstrated the expediency of feeding fuel oil into the hearth of the furnace through the tuyeres. Oil residue was not deposited on the walls of the tuyeres; only in a few did there occasionally appear to be a minor growth of residue, and these were easily removed by stopping the feed of fuel oil to the particular tuyere.

In general, the power-driven sprayers are of relatively simple design (without thermal insulation or cooling), and their performance has been fully satisfactory when the usual requirements for operating heating units have been met. However, the presence of the swirler and the small diameter of the exit aperture created strict maintenance requirements which, if not fully met, caused the sprayers to get out of order.

Furthermore, simplifications have been introduced in the method of feeding fuel oil at the Chusov plant where the temperature of the blast is relatively low-of the order of 750-800°. The sprayer has been replaced with an ordinary pipe 3/4 in. in diameter. The end of the pipe protruding into the nozzle eventually burns, due mainly to the deposition of residue. As the pipe is burned off, it is fed further into the nozzle as long as its length permits; then it is replaced by another . Under different conditions with higher temperatures, this method might be altogether unsuitable, since the pipe might burn off faster, and the feed of fuel oil could be interrupted. Under such conditions, it is clearly necessary to use cooled or insulated sprayers constructed of refractory materials.

The necessity of completing a system of feeding fuel oil into the furnace which would allow automation of the dispersion of the fuel oil according to the speed of the process has already appeared. The results obtained during the testing period were satisfactory.

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In order to determine the practical feasibility of using fuel oil in blast furnaces, experimental smelting was begun in 1960 at the Chusov Metallurgical Plant in which fuel oil was fed through the nozzles. The system for

TABLE 1. Comparative Thermotechnical Characteristics of Fuel Oil and Natural Gas

Properties of the fuel	Natural gas	Fuel Oil*	By-Product Oil Gas
Gas composition, %:			
CO_2	0.12	$C^g=87.6$	$CH_4=37.7$
O_2	-	$H^g=10.7$	$C_2H_6=18.4$
C_nH_n	-	$O^g=0.9$	$C_3H_8=18.3$
CO	-	$S^g=0.7$	$C_4H_{10}=6.1$
H_2	-	$N_2^g=0.1$	$C_5H_{12}=3.0$
CH_4	95.6	-	$N_2=16.5$
N_2	0.35	-	-
C_3H_8	0.66	-	-
C_4H_{10}	0.508	-	-
C_2H_6	2.74	-	-
Net calorific power, kcal/m^3..	8890	9700	12798
Density at standard conditions, kg/m^3	0.76	-	1.335
Air theoretically required for combustion, m^3/m^3. . .	9.87	11.02	14.0
Theoretical temperature of complete combustion of the dry fuel, °C	2050	2150	2050
Volume of products of combustion per unit of heat, m^3/1000 kcal	1.23	1.16	1.22
Reduction in coke consumption by injecting calorifically equivalent quantities (550 mg · cal/ton of iron of indicated fuel**; kg/ton of iron	68	95	62
Output of waste gas, m^3/kg of iron.	3.10	3.08	3.09
Theoretical temperature of the hearth gas,** °C	1935	1850	1960

*The figures on fuel oil are based on 1 kg of fuel.

**The data is obtained by the method of A. N. Ramm. Under identical conditions with a plain air blow, coke consumption is 760 kg/ton of iron, output of waste gas is 2.90 m^3/kg of iron, and theoretical temperature of the hearth gas is 2200°.

feeding fuel oil was developed jointly by the Ural Institute for Ferrous Metals, the All-Union Institute for Metallurgical Thermotechnics, and the Chusov Metallurgical Plant. For feeding fuel oil into the furnace, the All-Union Scientific Research Institute for Metallurgical Thermotechnics proposed the construction of a power-driven sprayer which was used in conducting the experimental smelting. As a result of local accumulation of residue, the sprayer proved unsuitable under continuous working conditions. The workers at the plant then replaced the sprayer with an ordinary steel pipe 3/4 in. in diameter.

The fuel oil arrived at the blast furnace from the open-hearth plant with an initial temperature of 45-50° and at 5-6 atm pressure(abs). At the experimental unit, it was additionally filtered and heated to 70°. Fuel oil was fed into the sprayers under a pressure of 3.0-3.5 atm(abs) at a rate of 1.5 tons/hr. During the experimental smelting period, the fuel oil mixture used contained 1.5% moisture and 1.1% sulfur.

In order to evaluate the effectiveness of blowing fuel oil into the furnace, the following periods of furnace operation were selected:

1. The average annual performance figures for the year 1959.

2. The month of best performance during the years 1959-1960—March, 1960.

3. The pre-experimental period (1-25 May, 1960).

4. The period of experimental smelting with fuel oil injection from 27 May to 22 June, 1960. Here is included a transition period with a gradually increasing ore load and also working periods with shutdowns which made performance figures worse but were not connected with the technology of the operation.

5. The best period of experimental smelting—14 to 17 June, 1960.

The technical-economic performance figures for the blast furnace and a comparison of them by periods are given in Table 2.

Feeding fuel oil into the furnace in amounts of 96-98 kg/ton of iron permitted the ore charge to be increased from 2.02 in 1959 and 2.20 in March and May, 1960 to 2.56-2.65 tons/ton of coke. In addition, the temperature of the blast was increased from 667° in the pre-experimental period to an average 732° during the period of experimental smelting, reaching 750° on the days of best performance. The average moisture content of the blast was decreased on the average from 28.5 to 18.8-19.1 g/m^3. In conjunction with the increased ore charge, the pressure of the blast rose from 0.67 to 0.77-0.80 atm. In spite of the increased pressure drop, the furnace operated more smoothly; the average daily number of rises and falls in performance during the experimental period totaled 0.52 as compared to 1.72 in the pre-experimental period and 0.71 in the month of best performance during 1959-1960.

TABLE 2. Technical-Economic Characteristics of Blast-Furnace Performance

Characteristics	1959 Average	Pre-Experimental Period, 1-25 May, 1960	Period of operation with fuel oil, 27 May-22 June, 1960	Month of Best Performance During 1959-1960—March, 1960	Period of Best Performance Using Fuel Oil, 14-17 June, 1960
Length of period, days	352	25	27	31	4
Fuel oil consumption per ton of iron, kg	-	-	98	-	96
Consumption per ton of iron, tons:					
ore	1.975	1.999	2.131	2.034	2.144
limestone	0.402	0.347	0.410	0.389	0.392
alloys	0.066	0.066	0.014	0.073	–
coke (dry)	0.944	0.910	0.833	0.926	0.810
Iron content of the ore component of the burden, %	49.5	48.1	46.35	47.9	46.5
Ore charges, tons/ton coke	2.09	2.20	2.56	2.20	2.65
Rate of coke consumption, tons/m^3·24 hr	1.202	1.099	1.048	1.159	1.061
Temperature of the blast, °C	680	667	732	723	750
Moisture content of the blast, g/m^3	22.4	28.5	18.8	23.6	19.1
Blast Pressure, atm	0.68	0.67	0.77	0.67	0.80
Temperature of gas at the mouth, °C	210	267	269	200	267
Composition of gas at the mouth, %:					
CO_2	10.3	10.1	10.35	10.4	10.5
H_2	1.6	1.6	3.5	1.5	3.4
CO_2/CO ratio in gas at the mouth	0.345	0.337	0.353	0.345	0.360
Iron composition, %:					
Si	0.46	0.53	0.54	0.54	0.52
S	0.04	0.041	0.039	0.05	0.040
Basicity of the slag $\frac{CaO}{SiO_2}$	0.92	0.95	0.955	0.875	0.937

The utilization of gas in the blast furnace was also improved: the CO_2/CO ratio in the gases at the mouth rose from 0.337-0.345 to 0.358-0.360. The rate of coke combustion dropped from 1.099-1.159 to 1.048-1.061 tons/m^3·24 hr,* but the rate of consumption of summated carbon (coke plus fuel oil) rose from 0.958-1.012 to 1.019-1.031 tons/m^3·24 hr. The high rate during 1959 is explained by the fact that the assumed furnace volume did not correspond to the actual volume as a result of wear of the refractories.

The experiments conducted on the blast-furnace process have shown that the injection of fuel oil is positively reflected in the performance of the tuyeres' zone of the furnace. The use of acid hearths led to improvement in gas distribution and allowed smooth descent of the burden under a more strenuous work load of the furnace.

In evaluating the effectiveness of using fuel oil during the period of best performance, it was found that production costs per ton of iron were reduced 0.6-1.4 rubles in comparison with other periods.

It must be noted that the charge for fuel oil is currently higher than its production and transportation costs. The actual summated labor input expressed by the value of the product is significantly lower when liquid fuel is used in the smelting process. Therefore, the possibility of lowering the price of fuel oil should be investigated in order to stimulate the utilization of fuel oil in blast-furnace smelting.

The capital investment which is necessary for installing a system of feeding fuel oil into the blast furnace is not large, and with a fuel oil tank of sufficient capacity it is insignificantly small.

The results of the work completed allow the following conclusions to be drawn.

*I.e., m^3 times the number of 24-hr periods [Publisher's note].

Under the conditions at the Chusov plant, the injection of fuel oil into the hearth of the blast furnace in amounts up to 100 kg/ton of iron while simultaneously raising the preheat of the blast by 65-80° and lowering its moisture content by 10 g/m^3 allowed a decrease in coke consumption of 11-17%, an increase in furnace output of 7-9%, and a decrease in production cost per ton of iron of 0.6-1.4 rubles in spite of a decrease in the iron content of the burden of 1.4-3.1%.

Effective utilization of fuel oil in the blast furnace is possible if either the preheat of the blast is increased and its moisture content decreased, or an oxygen-enriched blast is used. Exceeding the optimum input of fuel oil, which is determined by specific operating conditions in the furnace, may lead to a drop in temperature in the hearth below the permissible level and, consequently, to a disruption of the conditions for heat transfer.

Injection of fuel oil into the hearth of the blast furnace appreciably improved the condition of the tuyere zone which led to an increase in the permeability of the charge column and smoother and more constant operation of the furnace.

The actual performance did not confirm the conclusions drawn on the basis of theoretical considerations concerning the necessity of maintaining the theoretical combustion temperature at the tuyeres in order that the utilization of the combined blast be successful. Normal furnace operation is possible at lower hearth temperatures.

Further research on the use of fuel oil in blast-furnace smelting should be directed toward determining the necessary conditions for feeding sulfurous and high-sulfur fuel oil into the furnace, enriching the blast with oxygen, and perfecting the constructional design of a device for feeding fuel oil.

INCREASING THE STABILITY OF PASTES FOR TAPPING HOLES AND TROUGHS

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At the present time the problem of increasing the durability of pastes for tapping holes and troughs has acquired considerable importance since under conditions of intensive forcing of blast furnaces and conversion to 8-9 tappings, the quality of the refractory pastes should be sufficient for normal operation of the tapping holes, casings and troughs.

The main components of refractory pastes used in most of our blast furnaces are as follows: ground coke fraction 0-25 mm, refractory clay, fireclay powder and coal-tar pitch. The percentage content of individual components varies over wide limits (Table 1). The working life of the trough paste varies from one to three days and the quality of the tapping hole paste does not always provide normal conditions in the tapping holes.

A large amount of work has been done at the Voroshilov, Petrovskii and Krivoi Rog Metallurgical Plants to find high quality trough pastes. At these plants the main iron troughs are lined with carbon blocks and they are carefully maintained. The joints between the blocks are filled with ordinary paste. During the operation of the carbon troughs the blocks were also repaired with the ordinary raw carbon paste. Tests showed that troughs lined with carbon blocks at these plants last 6, 10 and 5 times longer, respectively, than ordinary troughs.

At some other plants the main iron troughs were lined with carbon brick or powder. These materials were made from pieces of carbon blocks after construction and general overhauls of the blast furnaces. Iron troughs lined with carbon brick or rammed with carbon powder had a life of about 15-18 days, i. e., about 6-7 times greater than ordinary. Despite the good results obtained, high-carbon materials in the form of blocks, bricks or powder have not found widespread application due to difficulties in preparing them in existing clay mills. In our opinion the problem of

TABLE 1. Composition of Refractory Pastes Used at the Metallurgical Plants of the South (from the Data of the Republic Interplant School for Blast Furnace Engineers, 1960)

Plants	Tapping Hole		Trough		Casing	
	Components	%	Components	%	Components	%
"Azovstal'"	Coke	53	Coke	73	Coke	42
	Clay part-1	27	Clay part-1	18	Clay part-1	42
	Pitch	20	Pitch	9	Pitch	16
					or	
					Coke	43
					Clay part-1	23
					Pitch	17
					Graphite	17
Il'ich	Coke	65	Coke	73	Coke:	
	Clay part-1	25	Clay part-1	18	fraction 0-3 mm = 80%	
	Pitch	10	Pitch	9	fraction 3-5 mm = 20%	30
					Silvery graphite	30
					Clay part-1	30
					Pitch	10
Kirov	Coke	52	Coke	77	Coke	50
	Clay part-1	32	Clay	11.5	Clay	33
	Pitch	16	Pitch	11.5	Pitch	17
Voroshilov	Coke	50	Coke	62	The same as tapping hole	
	Clay part-1	30	Clay part-1	21		
	Pitch	10	Pitch	17		
	Fireclay powder	10				
Dzerzhinskii	Coke	68	Coke	67	Coke	44
	Clay part-1	20	Clay part-1	11.5	Clay part-1	27
	Pitch	12	Pitch	21.5	Pitch	9
					Fireclay powder	20
"Zaporozhstal'"	Coke	70	Coke	70	The same as trough	
	Clay part-1	20	Clay part-1	15		
	Pitch	10	Pitch	15		
Krivoi Rog Metallurgical	Coke	77	Coke	72	The same as tapping hole	
	Clay part-1	17	Clay part-1	14		
	Pitch	6	Pitch	14		

Note: The composition of the paste is given in volume percentages.

preparing high-carbon materials should be solved at the level of a Council of National Economy so that a specialized factory could provide finished trough material or semi-finished product, not requiring complex operations to complete it.

Operating experience at our plant has shown that with a well chosen composition it is possible to achieve a sharp increase in the life of refractory pastes. At our plant we use the following materials in their preparation: coke of the fraction > 25 mm, Chasov-Yarsk refractory clay part-1 and coal-tar pitch.

In contrast to other plants for the preparation of refractory pastes we do not use the 0-25 mm coke fraction but the ordinary metallurgical coke fraction > 25 mm. This made it possible to reduce the amount of ash in the finished paste, to increase the mechanical strength of the ground coke, to increase the content of carbon in the paste and therefore to achieve greater strength and chemical neutrality with respect to the products of blast furnace smelting. The increased cost of the finished paste is economically justified because of the longer life and hence the smaller amount of refractory clay needed.

TABLE 2. The Chemical Composition of Tapping Hole and Trough Pastes Used at the Southern Plants

Plants	Chemical composition, %															
	tapping hole paste								trough paste							
	SiO_2	Al_2O_3	CaO	MgO	C	Fe_2O_3	FeO	other	SiO_2	Al_2O_3	CaO	MgO	S	C	Fe_2O_3	other
Krivoi Rog	18.2	5.9	—	—	78.9	—	2.9	—	18.5	9.3	—	—	—	69.6	0.74	—
Kirov	32.8	14.0	—	—	—	—	—	48.6	31.3	14.6	—	—	—	—	—	48.0
Voroshilov	27.0	17.7	1.7	1.4	48.8	2.9	—	50.0	No analyses							
Dzerzhinskii	27.0	16.24	0.54	0.70	—	1.96	—	52.8	21.3	13.4	0.62	—	—	—	2.13	60.0
"Zaporozhstal'"	—	—	0.96	0.57	—	4.32	—	59.04	—	—	2.45	0.66	1.08	—	5.75	59.2

Dehydrated coal tar (pitch) is used at our plant with a softening temperature of 46-50° (All-Union State Standard 1038-41). In our opinion pitch with a higher softening temperature (135-150°, Voroshilov Plant) should not be used since, during ramming of troughs and casings and the application of the paste to the tapping hole, a temperature of about 150° and above is transmitted into a small depth of the raw paste, which weakens the density of the ramming. On drying there is a large amount of shrinkage and a sharp reduction in the wear-resistance of the paste. Tests on different experimental pastes showed that the use of 6-7% pitch in tapping hole pastes and 14-15% in trough pastes makes the latter more stable. Since pitch slightly reduces the wettability of the paste by iron and slag, its use in large amounts (especially in the tapping hole pastes) is optional.

As can be seen from Table 1, at our plant casing paste has the same composition as tapping hole paste, only it contains less moisture–about 5%. The method for preparing casing paste is as follows. Pieces of tapping hole paste are made in a certain shape–a prism measuring 70 x 70 x 200 mm. For 1-1½ days the prisms are dried under natural conditions to obtain a semidry paste. The life of the casings of the iron tapping hole at our plant is 1-2 days.

Good experimental results on increasing the stability of casing pastes were achieved by blast furnace engineers at the Dzerzhinskii Plant. For its preparation they used roasted magnesite powder containing 12% of the 0-0.8 mm fraction and 88% of the 0.8-5.0 mm fraction. The powder is carefully mixed and moistened with liquid coal tar pitch in quantities of 10% of the total volume. The new casing of the iron tapping hole is rammed after preheating the paste to 50-60° and it is dried only till it becomes red. The working life of this casing is about 8-10 days, i. e., 5-6 times longer than usual.

To achieve a stable composition of refractory pastes at our plant there is systematic checking of their chemical composition. Table 2 gives the chemical composition of tapping hole and trough pastes of our plant and some others.

As a result of steps taken to find the best compositions of ordinary pastes under the operating conditions of our plant it has been possible to increase the life of trough pastes to 3-5 days and a well selected composition of tapping hole pastes makes it possible to keep the iron tapping holes permanently in the normal state.

AUTOMATIC CONTROL OF THE TILTING RATE OF THE LADLE DURING THE CASTING OF IRON

V. I. Beloshabskii and A. L. Shteiner

Translated from Metallurg, No. 5,
pp. 10-12, May, 1961

In the 7-Year Plan for the development of the national economy considerable attention is paid to problems of automation of production processes and, chiefly, laborious operations in ferrous metallurgy plants. These operations include the casting of iron in the blast furnace departments of the metallurgical plants. However, despite the frequent attempts to automate this process iron is still being cast manually.

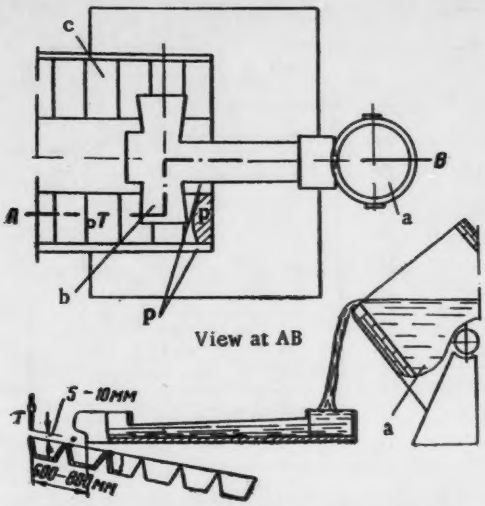

Fig. 1. Plan of working area of casting machine and position of apparatus. a) Ladle ; b) pouring trough ; c) molds of casting strip ; T) thermocouple ; P) region controlled by photorelay.

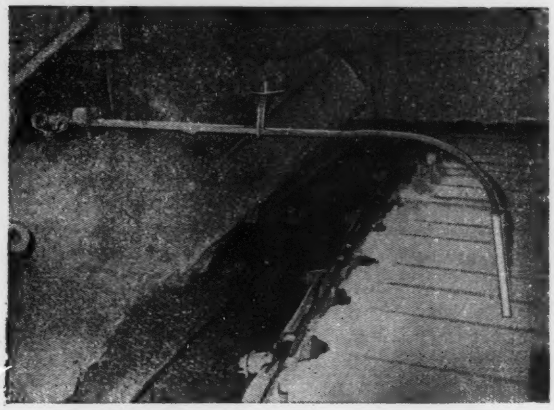

Fig. 2. Arrangement of thermocouple above molds.

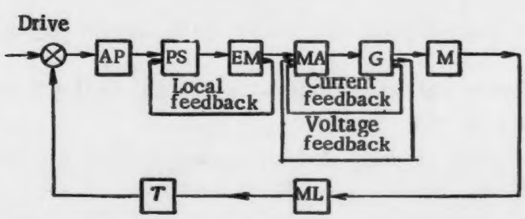

Fig. 3. Block-circuit of system for automatic control of ladle tilting. AP) Automatic potentiometer ; PS) proportional speed floating controller ; EM) executive mechanism ; MA) magnetic amplifier ; G) generator ; M) motor for lifting winch ; ML) metal-pouring ladle ; T) thermocouple.

In our opinion the lack of success is due to the fact that the proposed plans do not control the true filling of the mold with iron and the impulses for the change in speed of the motor for the tilting winch are given in dependence on the geometrical position of the ladle or as a function of the time. The authors of the present article* have suggested a method for controlling the rate of inclination of the ladle in dependence on the filling of the molds during the casting of iron on a casting machine. The method was tested in Scientific Research Institute for Metallurgy of the Chelyabinsk Council of National Economy and introduced into the Chelyabinsk Metallurgical Plant. The results of experimental 3-month operation of the suggested scheme have shown the technical suitability and the economic desirability of its use.

The detector for the filling of the molds with iron is a chromel-alumel thermocouple suspended at a height of 5-10 mm above the highest level of metal in the molds at a distance of 600-800 mm from the end of the pouring trough (Figs. 1, 2). Through the mold filling detector the thermocouple is connected to an automatic potentiometer. From numerous measurements it has been found that the potentiometer readings depend on the level of iron in the molds.

The output rheostat of the potentiometer is connected to the IR-130M proportional speed floating controller which, through the executive mechanism IM-2 x 120, acts on the resistance controlling the current in the circuit of the control winding of the magnetic amplifiers (Fig. 3). These amplifiers feed the excitation winding of the generator of the motor for the tilting winch of the casting machine.

Figure 4 shows the circuit for connecting the instruments in the device for the automatic casting of iron. The automatic control of the mold filling is provided in the following way. If for some reason the level of metal in the molds becomes less than the given level, the value of the thermoelectromotive force of the thermocouple decreases, which causes a displacement of the moving arm of the resistance pickup of the automatic potentiometer. The proportional speed floating controller then gives an impulse for switching on the motor of the executive mechanism in the direction of increasing the resistance in the circuit of the demagnetizing windings for controlling the magnetic amplifiers. The resulting ampere-turns of the magnetic amplifiers increase, the excitation and, consequently, the voltage of the generator increase, leading to an increase in the speed of the motor for the tilting winch. The faster tilting of the ladle causes an increase in the level of iron in the molds until it reaches the given value.

*Claim No. 664101/22 from April 19,1960 for Certificate of Authorship.

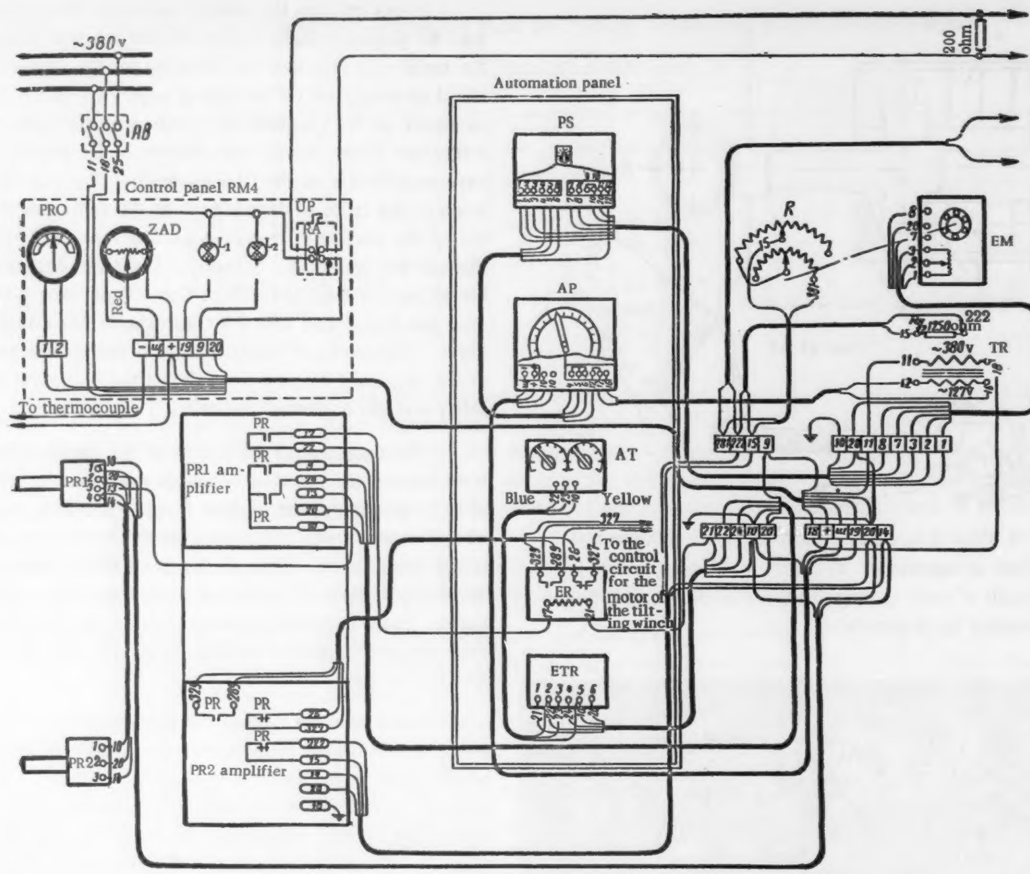

Fig. 4. Circuit of device for automatic casting of iron. ETR) Electronic time relay; AP) automatic potentiometer; ER) electromagnetic relay; PR) photorelay with amplifier; TR) transformer; L_1, L_2) signal lamps; back dial of drive (other symbols as in Fig. 3).

By selecting the settings of the degree of nonuniformity and the doubling time of the regulator an aperiodic character of the transition process is achieved.

With increase in the level of metal in the mold above the given value the automatic control system acts on the motor for the tilting winch, reducing the speed. The circuit includes protection against overcasting of the metal, which can occur, for example, when a lump of waste material is torn from the lip of the ladle.

The photorelay PR1 is directed below the end of the casting trough to one mold into which the metal falls only during overcasting. In Fig. 1 the region controlled by the photorelay PR1 is shaded and represented by the letter P. When molten metal falls into this region the photorelay PR1 operates and through an intermediate relay ER it reverses the motor of the tilting winch. The signal lamp L_2 on the control panel then lights up.

The time for lowering the ladle during reverse is determined by the delay of electronic relay ETR and is established during alignment by means of an attachment to the ETR relay, shown in Fig. 4 by the index AT.

During an emergency overflow, when the metal falls onto the working area, the photorelay PR2 operates, reversing the motor of the tilting winch, introducing into the circuit of the demagnetizing windings of the magnetic amplifier control an additional resistance R_{A_2}, which causes the ladle to be lowered with a greater speed until the motor is switched off by the final switch.

b

a

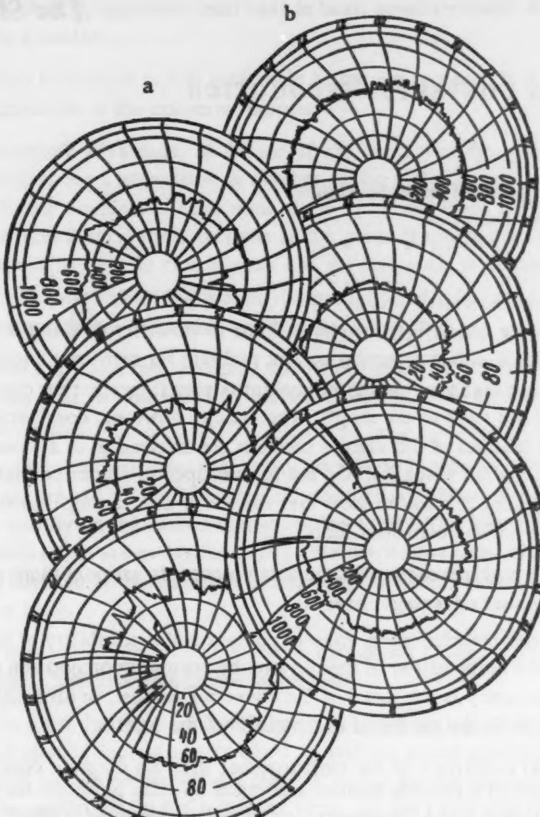

Fig. 5. Diagram of filling of molds with iron. a) With manual control; b) automatic control.

During the experimental operation the potentiometer readings were recorded with manual and automatic control of the tilting winch motor (Fig. 5). By comparing these curves it can be seen that with automatic control the molds are filled much more evenly than with manual control.

Observations showed that the arrangement operates stably, keeping a given level of iron in the molds with an accuracy of up to 5%. With automatic control of the manipulating winch motor the rate of casting for iron is increased by 10.3%, the losses of iron at the cones are reduced.

Automatic control of the tilting rate of the ladle during the casting of iron permits the use of complex automation in casting machines.

USE OF SCRAP METAL IN CONVERTER PRODUCTION

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Head of the Converter Shop of the Petrovskii Plant
Translated from Metallurg, No. 5,
pp. 13-15, May, 1961

The article by S. G. Afanas'ev and B. E. Gurevich on "The Desirability of Using Scrap in Converter Production," published in Metallurg, No. 12, 1959, raises a very important problem for converter production. The authors of the article quite rightly point out that the "choice of coolant is very important for converter melting, since it large ly determines the organization of the work of the shop". The article, however, does not examine the individual factors fully enough. The technical features of the various methods are referred to in a casual manner and their principal advantages and disadvantages are not revealed. On the basis of special numerical data, isolated economic effects and general considerations, an attempt is made to show that the use of scrap in top-blown converters is economically unprofitable and reduces the output of the converter shop.

A closer examination of the problem shows that the scrap process is not only more economical than the ore process, but has considerable technical advantages over it.

The chief feature of converter practice using scrap as coolant is the possibility of strictly standardizing the process almost independently of the composition of the pig iron by accurate composition of the charge according to heat carrier. The guarantee of accuracy is the speed of the converter process, in eliminating the influence of the oxidizing capacity of the aggregate on the chemical composition of the melt.

The uniformity of the initial conditions of the melt together with the constant cooling effect of the scrap enables the process to be controlled in a reliable manner and opens up wide prospects for its automation. For instance a L-D shop (at the plant of the Algoma Steel Corporation in Canada) operates with scrap, and termination of the heat on a given carbon content is fairly exactly adjusted according to the time and the consumption of oxygen per minute.

Independence of the composition of the melt on the composition of the pig iron has another important consequence: it renders unnecessary the mixer, the function of which is practically reduced to zero when iron scrap is used. Modern L-D shops abroad are currently being built without mixers, being supplied with pig iron direct from the blast-furnace hot-metal ladle with adjustment of the chemical composition of the melt by addition of scrap to the charge (Dofasco plant and plant of the Algoma Steel Corporation in Canada, plant of the Jones and Laughlin Steel Corporation in the U. S. A. and others). The elimination of the mixer reduces not only the capital expenditures on the equipment of converter shops but also the cost of the steel-melting process in them.

In addition to the positive sides enumerated of the use of scrap, resulting from the low and constant silicon content in the melt, there are: technical simplicity, moderate flux consumption and correspondingly low slag yield, high basicity of the slag throughout the entire heat, constant temperature conditions, ensuring a relatively low temperature of the metal during the blow and its heating to specification only at the end of the heat, and increased life of the converter lining.

A characteristic feature of the process using ore is the complexity of the control of the latter, due to fluctuations in composition of the pig iron, as well as variations in the cooling effect of the ore and the quantity of oxygen which it introduces into the bath. It is quite impossible to allow for these fluctuations accurately and in good time in industrial conditions; it is therefore unavoidable that there will be differences in the actual parameters of the heats, complications of the blow due to ejected material preventing it from being forced, and the need for adding ore in small portions, a difficult matter to organize.

All this results in sharp differences between one heat and another, which considerably complicates the way to automation of the process and its continuous control according to the course of the blow. At the Petrovskii Plant, for example, as the result of lengthy investigations by the Central Automation Laboratory, the Ukrainian Institute of Metals and the Dneprodzerzhinskii Metallurgical Institute, two types of reproducible converter flame radiation curves have been obtained. The physico-chemical measuring devices of the process, however, cannot be tied to characteristic points on these curves without considerable scatter, which prevents their use in controlling the heat. The cause of

this is the difference in the blowing operation from heat to heat, associated with the difficulty of standardizing the process when ore is used as a coolant.

The technical use of scrap as coolant is thus preferable to the ore process. It is simpler in technique and opens up wider prospects for the automation of the converter process.

An assessment of the economic advantage of the use of one coolant or the other can only be made by comparing the consumption in blowing iron of one composition or another by the different processes. A calculation of the economic effect of using the different coolants in conditions of the Petrovskii Plant for pig iron containing 4.2% C, 0.7% Si, 1.2% Mn and 0.2 % P shows that despite some increase in the yield of useful material and a saving of oxygen blast, the lime consumption is increased by 48.7 kg /ton of melt and the slag yield is doubled, involving double expenditure for slag removal, both in capital costs and on the process; consumption of refractories is increased by 2.3 kg/ton of melt; and the transport of various loads is increased by 182.5 kg/ton of melt.

If all these circumstances are taken into account, the overall result of the calculation is an increase in the cost of steel made by the ore process over its cost made by the scrap process, even assuming the prices of pig iron and scrap to be the same.

The statement that the output of converter shops using scrap iron is reduced by about 6.25% in proportion to the time spent on charging is easily refuted by the following considerations. The length of blow for constant rate of oxygen consumption depends mainly on the carbon content of the melt. The initial carbon content of the bath when scrap is used is decreased relatively to the carbon content of the pig iron in proportion to the quantity of scrap added. It is thus possible not only to cover fully the time lost in charging the scrap, but to increase the converter output by cutting down the length of the blow.

The calculation shows that when pig iron of the above-mentioned composition is converted, the carbon content of the melt in the scrap process is 24% less than in the ore process.

According to data of the State Institute for the Planning of Metallurgical Plants, confirmed by practice at the Petrovskii Plant, the length of blow is approximately equal to half the entire operation. This means that the increase in output due to the decrease in carbon content of the melt, allowing for the loss in time for charging the scrap, is $\frac{24}{2} - 6.25 = 5.75\%$. This can be confirmed by the following facts. At the Petrovskii Plant using the ore process, with an oxygen blast supply of about 2.8 m^3/min · ton, 1.8 tons of melt are blown per minute (calculated by dividing the weight of the melt by the time for blowing alone), while at Canadian plants using the scrap process, this figure is 3 ton/min, and 3.1 ton/min for a lower specific oxygen consumption of 2-2.25 m^3/min · ton.

In addition, it is necessary to take into account the increase in the utilization factor of the converter with increase in the life of the lining, due to the easier conditions of its service in the scrap process. Our calculations show that in the scrap process, due to the improvement in the utilization factors of the converters, the output of the converter shop is increased by 3% in comparison with the ore process. The total increase in output of the shop will be: 5.75+3 = 8.75%. Taking into account the fact that in modern converter shops, with top blowing with oxygen, charging of the scrap is done by the cranes otherwise used for transferring metal and does not require any additional equipment, as well as the fact that the scrap is charged on to the most durable parts of the lining, i. e., the bottom covered with a coating of slag and practically incurring no risk of damage, the advantages of the use of scrap become obvious.

The foregoing considerations do not permit one to agree with the view that the extensive application of scrap in converter practice abroad is due merely to its cheapness compared with pig iron. The real cause resides in high technical, economic and organizational advantages of the scrap process.

The opinion of S. G. Afanas'ev and B. E. Gurevich that due to the reduction in output of open-hearth furnaces when the pig-iron content of the charge is increased above 60-65%, it is advantageous to use scrap in the open-hearth process is also not convincing. It is known, for example, that the open-hearth furnaces of the Kursk Metallurgical Combine operate successfully on 63% of pig iron in the metal part of the charge and of the NT Metallurgical Combine on 68% of pig iron. In England, in the open-hearth furnaces of the Appleby-Frodingham works, the consumption of pig iron is 850 kg/ton of steel and in the Ajax type of furnace it is 1070 kg/ton.

To increase the quantity of pig iron in the charge of open-hearth furnaces above 70%, however, is undesirable for the same considerations as the use of the ore process in converter shops. In this case, the increase in the consumption of fluxes and the like materials, together with the increased slag yield, increases the cost of the steel and complicates production. Thus, purely the ore process is equally unacceptable and for the same reasons both for converter

shops and open-hearth shops. The interest in the development of both processes of steel production makes essential a certain minimum of scrap in the charge. For converters, this minimum is 15-25% and for open-hearth furnaces, it is 30-35% of the metal part of the charge. The excessive increase in the use of ore in Russian oxygen-blown converter shops arouses in some specialists a sceptical attitude to the new and progressive process, and in many respects impedes its development.

Thus, the ore process, in oxygen-blown converter shops, compared with the use of scrap is uneconomical, complicated from the technical and organizational point of view, impedes the automation of the process and demands higher capital expenditure in the equipment of mixer departments, and increased means for slag removal and internal transport.

The successful development of both converter and open-hearth production demands the guarantee of a certain minimum of scrap in the charge of both converters and open-hearth furnaces. The proper way to solve this problem is to increase the quantity of pig iron in the charge of open-hearth furnaces, using hot metal, to 65-70%, and to use the scrap thereby liberated in the converter shops.

A HOT TOP WITH AIR SPACES IN THE WALL

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"Azovstal' " Plant and Zhdanov Metallurgical Institute
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A lined top ensures slow cooling of the metal at the top, acting as a feeder for the lower layers of the solidifying steel. The heat from the top is conducted into the body of the ingot, is lost through the surface of the metal and the housing of the top and is absorbed by its refractory lining. At the present time at the "Azovstal'" Plant the thickness of the linings for ordinary hot tops is 120 mm. According to literature data brick acts as a thermal insulator only to a depth of 30-40 mm thickness. Replacing the fireclay brick by insulation brick reduces the heat losses by 70% since its coefficient of thermal conductivity is 6 times less than that of fireclay brick.

Work at the plant has shown that with a lining thickness of 120 mm in 24 heats a layer of not more than 50-60 mm thickness is worn. After 24 heats the old lining chips off.

One of the best insulators is air since its coefficient of thermal conductivity at 20° is about 38 times less than that of fireclay brick and 7 times less than foamed fireclay.

At various plants different attempts have been made to use the thermal insulation properties of an air layer. A gap is most conveniently provided by means of a hollow molded brick, as was done at the Kuznetsk Metallurgical Combine*. However, this solution is only possible when the plant has a ceramics department, which the "Azovstal' " Plant does not. Since the refractory plants do not make molded brick, in developing a method for lining the hot tops it was necessary to start from standard brick sizes and shapes.

The design of the hot top was changed in two ways. In the first case in the body of an ordinary top steel sheets of thickness 8-10 mm were inserted and fastened by electric welding so that an internal case was formed at a distance of 70 mm from the external case and lined after fitting with fireclay brick grade PM45 measuring 113 x 40 x 230 mm.

In the second case a special hot top was used with horizontal ribs on the middle of the height of the body, carrying PM45 brick. The air clearance between the brick lining and the body is about 60 mm. To give the lining greater stability the corners of the top were lined with ordinary fireclay brick PM17, laid on edge. From experimental data a thermal balance was compiled for the ordinary tops and the tops with an air layer. For this purpose the temperature distribution was determined along the thickness of the walls of the tops.

*Metallurg, No. 5 (1957).

The thin layer of refractory lining in the top with an air layer is heated through 60 min after filling the top with metal; the 120-mm lining in the ordinary hot top takes more than two hours to heat through (Fig. 1). The amount of heat accumulated by the refractory lining in the second case is much greater than in the first. The heat losses in heating the body of the top and also convection and radiation to the surrounding medium increase as the refractory lining heats through.

In the hot top with an air layer the losses due to convection and radiation from the outside surface of the case toward the end of ingot solidification are somewhat higher than in the top with an ordinary lining, due to the higher temperature of the case.

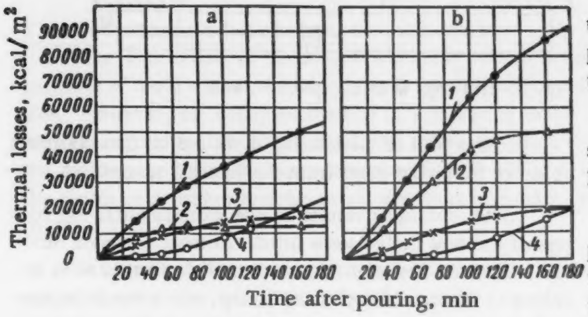


Fig. 1. Change in thermal losses with time through the side surface of a hot top with an air space (a) and with ordinary lining (b). 1) Total heat losses; 2) heat used in heating the lining; 3) heat used in heating the case; 4) heat losses to the surrounding medium.

The total heat losses through the side surface of the top with an air space in the wall up to the moment of complete solidification of the ingot are about 60% of the losses through the side surface of an ordinary top.

The lower level of total thermal losses through the side surface of the hot top with an air space should provide a longer time of existence of molten metal in the hot top.

The improvement in the thermal insulation makes it possible to somewhat reduce the volume of the metal in the top. In the air-layer top it was 14% while in an ordinary hot top it was 15% of the weight of the ingot. By reducing the weight of the top the weight of the body of the ingot can be increased, so that the top part of the body of the ingot, which is the most contaminated with nonmetallic inclusions, can be cut off.

The distribution of heat losses in the top in the experimental and ordinary hot tops is shown by the following data, %:

	Hot top with ordinary lining	Hot top with air clearance
Total heat losses of hot top toward the end of solidification of ingot, %	100	59
Of these:		
losses to surrounding medium	22	45
absorbed by refractories of hot top	56	24
absorbed by case of hot top	22	31

Six ingots were cast (from two heats) into molds with hot tops having an air layer. From the first rails every 2 meters of length samples were taken for macroinspection, the results of which were satisfactory. To obtain sulfur prints two rail ingots weighing 9.76 tons were cut, these ingots having been cast using the experimental tops, heated with coke-lime mixture and lunkerite. The sulfur prints from both ingots showed a satisfactory macrostructure (Fig. 2).

The introduction of the hot top with an air space into mass production has been hindered by the short life of the lining. Under the pressure of gases filling the clearance they broke down and the metal often penetrated into the space, rendering the hot top unserviceable. Sometimes, when the top was filled with metal there were bangs, accompanied by ejections of metal, which could cause accidents. To eliminate these faults a new modification of the hot top has been developed and is shown in Fig. 3.

In the new modification there is uniform hanging of the ingot over the whole perimeter at the line of the joint between the mold and the top. For this purpose the internal transverse section of the top (885 x 790 mm) was made larger than the internal section of the mold (865 x 770 mm). To prevent the top rows of the lining from falling into the case of the top 50-mm wide grooves were made.

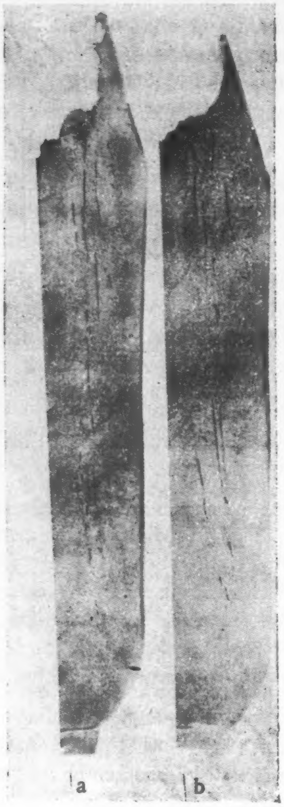


Fig. 2. Sulfur prints from a 9.76-ton rail ingot. Hot top with air clearance in the wall. Charge: a) coke-lime dust; b) lunkerite.

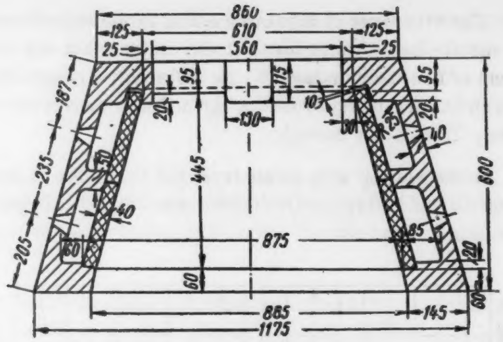


Fig. 3. Hot top with air space in wall.

In the wall of the housing there are 50 mm diameter holes for removing gases from the internal spaces.

After obtaining results on one experimental top 20 tops of the new design were lined. In these 17 heats were cast: after the first eight in 2-3 tops disturbances were recorded in the continuity of the lining, which could be easily corrected . After 17 heats the lining of the experimental tops became unserviceable. The average life of ordinary hot tops at the "Azovstal' " Plant is 24 heats. At the Kuznetsk Metallurgical Combine the life of heats lined with molded hollow brick is 10-12 castings. It therefore follows that tops with an air space lined with straight brick do not have a shorter life than tops with molded brick.

No transverse cracks were found on inspecting the surface of 97 experimental ingots on putting them into soaking pits of the blooming mill. This is presumably due to the increase in the bottom transverse section of the top.

The use of hot tops in mass production without shoulders should lead to a decrease in the number of samples in the head rails found unsuitable due to nonmetallic inclusions. At the present time at the "Azovstal' " Plant from 20 to 40% of the samples taken in macroinspection are rejected due to nonmetallic inclusions. The reduction in contamination by nonmetallic inclusions will considerab' improve the quality of rails from the "Azovstal' " Plant.

IN THE OPEN-HEARTH DEPARTMENTS OF THE USSR

Translated from Metallurg, No. 5,
pp. 18-22, May, 1961

The Mechanized Lubrication of Molds. V. M. Borevskii

The lubrication of molds with Kuzbassk varnish is one of the most laborious and dangerous operations in the preparation of mold trains. At many plants special lubrication machines have been introduced to mechanize this operation. However, the accepted method of lubricating molds before arranging them on the stools had a serious fault; after installing the lubricated molds the refractory paste did not always dry, since under the conditions of this method the molds were lubricated at temperatures of 60-100°. After lubrication there is about 2-3 hr more; during this time the molds cool further and the remaining heat is usually insufficient to dry the refractory paste at the bottom of the mold.

At the Chelyabinsk Metallurgical Plant they have introduced a new original method for lubricating molds on a prepared train. For this purpose they have built a special section for lubricating molds, to which the completely assembled train is sent, where the molds are lubricated through the already fitted hot tops.

In the lubrication section are found a lubrication machine and a rack pusher for pushing the trains.

The machine consists of a stationary bridge and a moving trolley (Fig. 1). On the trolley in the vertical position moves a pipe which ends in a spray rotated by compressed air. The walls of the molds are lubricated during the ascent and descent of the pipe in two cycles.

During the rotation of the spray the varnish falls on an impeller, is atomized and the walls of the mold are coated with a uniform thin layer. The varnish is fed to the pipe along hoses by air at a pressure of 3-4 atm abs.

The operation of the lubricating team under winter conditions involved considerable difficulties. A comprehensive development team was therefore set up, consisting of the engineers and technicians Polushin, Cheberko and Zavarukhin and the development workers Yartsev, Vitoshnev and Bogachev. After an intensive 3 months of work the machine was developed and is now in operation.

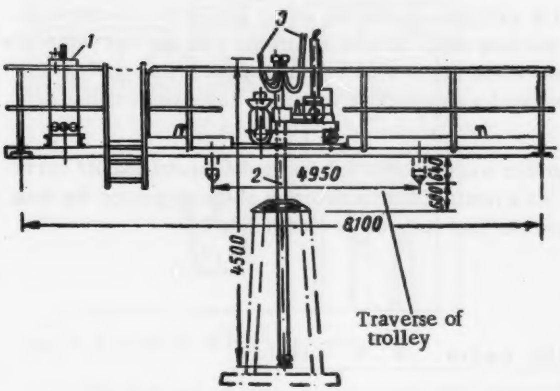


Fig. 1. Machine for lubricating molds. 1) Tank for resin; 2) pipe; 3) hoses.

For operation under winter conditions it was necessary to carefully thermally insulate the service tanks containing varnish (Fig. 2), the varnish- and air-pipes, rods, hoses, etc. A special tank was built (Fig. 3) to heat the spray to prevent it solidifying in the periods between lubrication. The tank contained a special steam-heated coil. A steam pipe is laid in the supply pipe for heating. The varnish is specially heated to prevent it thickening due to the cold air.

The whole control of the machine and pusher is concentrated in the heated control panel of the operator. The lubrication of molds, especially those with blind bottoms for bottom casting of quality and high-grade steels, is essential to keep the flow of varnish to the bottom at a minimum. For this purpose, as the varnish enters the varnish pipe, there are special finely dispersed filters, and the feed of varnish is stopped until the finish of the cycle, so that the lubrication is carried out with the varnish remaining in the rod.

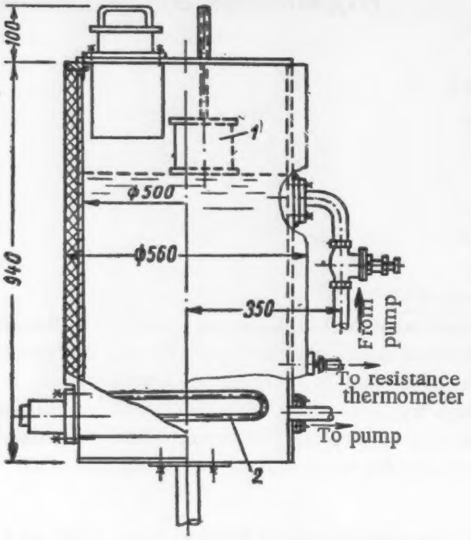


Fig. 2. Tank for varnish. 1) Float; 2) electric heater.

All these measures have made it possible to mechanize the lubrication of molds for casting of killed steel, releasing eight men from this laborious and dangerous operation.

The operator and his assistant now lubricate 9-13 trains in a shift whereas with the manual system of operation 4 men lubricated about 8 trains in a shift.

Without adversely affecting the quality of the lubrication the new method made it possible to arrange molds on trains at a temperature providing complete drying of the refractory paste under the bottom of the molds, as a result of which there were no metal losses.

The introduction of this new method of lubricating molds ensures a supply for the casting of open-hearth heats of molds with fresher, dust-free lubrication which in its turn makes it possible to obtain ingots with a better quality surface.

Improving the Heat Engineering Data of an Open-Hearth Furnace. V. P. Emel'yanov

In order to improve the heat engineering indices of regenerator operation and to reduce the time of heats at two of the open-hearth furnaces of our combine, S. T. Zinov'ev, N. I. Kochetkov and D. V. Yudin have put forward the following suggestion.

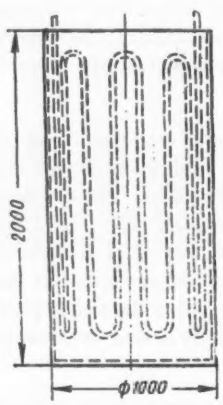


Fig. 3. Tank for heating spray.

In the space between the slag pocket and the dam wall of the regenerator chamber a 460 mm thick wall was built at a distance of 1 m from the dam wall, dividing the slag pocket and the regenerator chamber. Because of the reduction in the regenerator checkerworks the volume of the slag pocket has been extended, thus improving the distribution of air, gas and smoke throughout the section of the checkerworks and increasing the temperature of the air and gas.

Furthermore, this extra wall prolongs the life of the part of the checkerworks between the new wall and the dam wall. In cold repairs the wall and this part of the checkerworks are not broken, which together with the reduction in the number of rejected checkerworks has produced a considerable reduction in the consumption of refractory materials.

The bottom of the furnace was reconstructed during the repairs and did not require additional expenses. As a result of the introduction of the suggestion the time of the heats at these furnaces has been reduced by almost 1 hr.

Mechanizing the Feed of Ferroalloys into the Ladle. V. V. Aristov

At the open-hearth department of the Izhevsk Metallurgical Plant the feed of ferroalloys to the ladle has been mechanized in the following way (Fig. 4).

The ground and fluidized ferroalloys from the mold of the charging machine are poured into a scoop mounted on a light trolley which moves along a rail. The trolley with the scoop moves into the balcony of the working area in the casting bay–in the zone of operation of the casting crane.

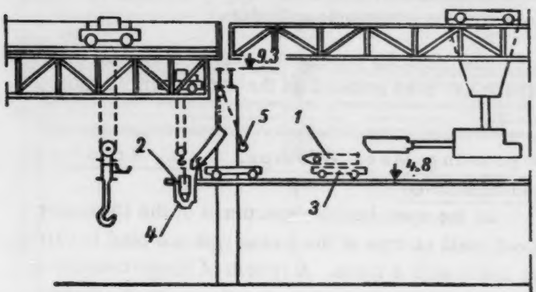


Fig. 4. Loading bin. 1) Scoop; 2) bin; 3) trolley; 4) holder for bin; 5) winch.

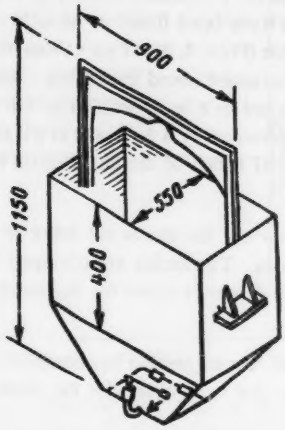


Fig. 5. Overall view of bin.

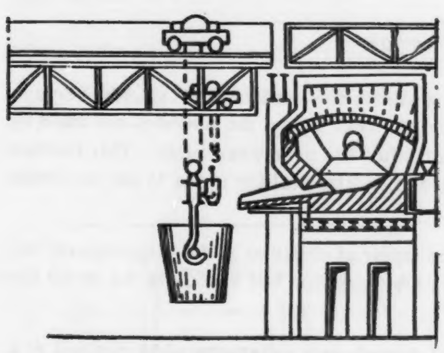


Fig. 6. Suspension of bin on crosspiece.

On the balcony, on the floor of the working area there is a holder with a 0.4 m^3 bin (Fig. 5), into which the ferroalloys are poured from the scoop. The scoop has on its sides small journals which rest on stands welded to a plate of the working area when the scoop is tilted over the bin. A small manual winch is used to tilt the scoop over the bunker.

Before the heat is received the bin with the ferroalloy is hoisted by the hook of an auxiliary trolley of the casting crane and is hung on the crosspiece of the main trolley on the side of the line of furnaces (Fig. 6). After the ladle has been filled to one-third with metal from the working area a light hook is used to open the closing mechanism of the bin and the ferroalloys are poured into the ladle. The closing mechanism of the bin consists of a swivel pin and a protective cotter.

After the heat has been cast the crane again places the bin in the holder on the balcony of the working area where it is charged with ferroalloys for the next heat.

The bin need not be hung on the crosspiece of the ladle but it can be held over the ladle on the hook of the auxiliary hoist.

This method is more convenient and it can be used in a department where the trolley of the casting crane is placed high over the ladle and its mechanism is not affected by the high temperatures during the tapping of the metal.

Mechanizing Operations of a Freight Elevator. A. I. Yarmolenko and V. I. Shishkin

"Krasnyi Oktyabr' " Plant

Narrow-gage mold trolleys are used to feed the charge materials to the working platform in the open-hearth department of the "Krasnyi Oktyabr' " Plant. The trolleys with the molds are taken by locomotives to the freight elevators which lift them to the level of the working platform. Up to 1960 the delivery of mold trolleys to the cage, their removal from the cage of the elevator, rotation on the rotating circle and also the locking of the trolleys in the cage were done manually by small crowbar rollers.

In 1960 a group of development workers, Comrades Tsarev, Shishkin, Yarmolenko and Sukhodolov, mechanized all these operations.

The delivery of trolleys to the cage, the removal from it and rotation on the circle are mechanized by means of pneumatic cylinders with a piston stroke of 900 mm. The trolley is fastened in the cage in the following way (Fig. 7). When the cars enter the cage and the front wheel rolls on the clip the latter is withdrawn and frees the lever, which, under the action of the spring, rotates about the joint and moves the closing strip.

When the cage with the car is raised to the working area, the roller of the lever rolls onto the inclined plate fastened on the shaft of the freight elevator. The lever then moves the closing strip, freeing the trolley.

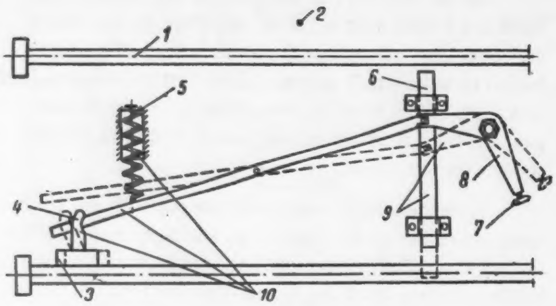


Fig. 7. Arrangement for automatic closing of trolleys on freight elevators. 1) Rail; 2) load cradle; 3) socket; 4) lever; 5) spring; 6) closing strip; 7) roller; 8) lever; 9) opening mechanism; 10) closing mechanism.

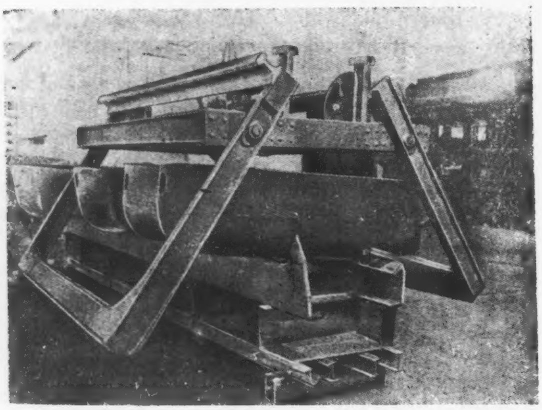


Fig. 8. Overall view of device.

At the present time the operation of the rollers is to control the pneumatic cylinders.

The time for putting the charge materials into the furnace has been reduced on the average by 10 min.

Improving Mold Clamps. A. Kosolapov

Uralvagonzavod

In the open-hearth department of the Uralvagonzavod mold clamps of the frame type are used to clamp the molds with a crane. A system of hinge-connected levers is used to manipulate the clamps by the frames. The system was complex and unreliable in operation and often caused lost time on the cranes and interrupted the normal operation of the department.

On the suggestion of A. V. Rychkov instead of a system of levers two rollers have been fitted on an axle in the upper part of the frame (Figs. 8, 9). Two cables of up to 1-1½ m length are wrapped round the rollers; one end of each cable is fastened to a lever welded to the frame and the second is fastened by a loop and is placed on the hook of an electrical winch of the mechanism for clamp manipulation.

The frame is opened and the molds are freed by pulling on the winch cables. The molds are clamped by the frames when the hook descends under the action of the weight of the frames.

The introduction of this suggestion has completely eliminated crane holdups due to trouble with the mold clamps.

Improving the Life of Tundish Linings. V. P. Emel'yanov

In many large open-hearth departments the steel is cast through tundishes—low containers lined with fireclay brick and having four holes so that four molds can be filled simultaneously. After lining, the tundishes are dried by gas burners. However, due to the swelling of the bottom of the tundish it often has to be lined again. This involves considerable labor costs and leads to overconsumption of refractory materials. The swelling is due to the accumulation of steam under the lining which prevents it from escaping.

A reduction in the consumption of material and manpower on the repair of tundishes at the Magnitogorsk Metallurgical Combine has resulted from a suggestion by Sh. Z. Gizyatov; the suggestion was to remove the steam from under the lining during the drying of the tundishes.

For this purpose in the bottoms of the tundishes holes were drilled through with a diameter of 10 mm and at a distance of 600 mm from one another in a staggered arrangement in three rows over the whole of the bottom. The same holes in one row are drilled on the wall of the tundish at 300 mm from the bottom. The holes allow free exit of steam and good drying of the tundishes. With the introduction of the suggestion cases of swelling during drying and dust losses from the lining during casting have stopped.

The reduction of consumption of only some refractory materials at one open-hearth department gives economies of about 3,000 rubles per year.

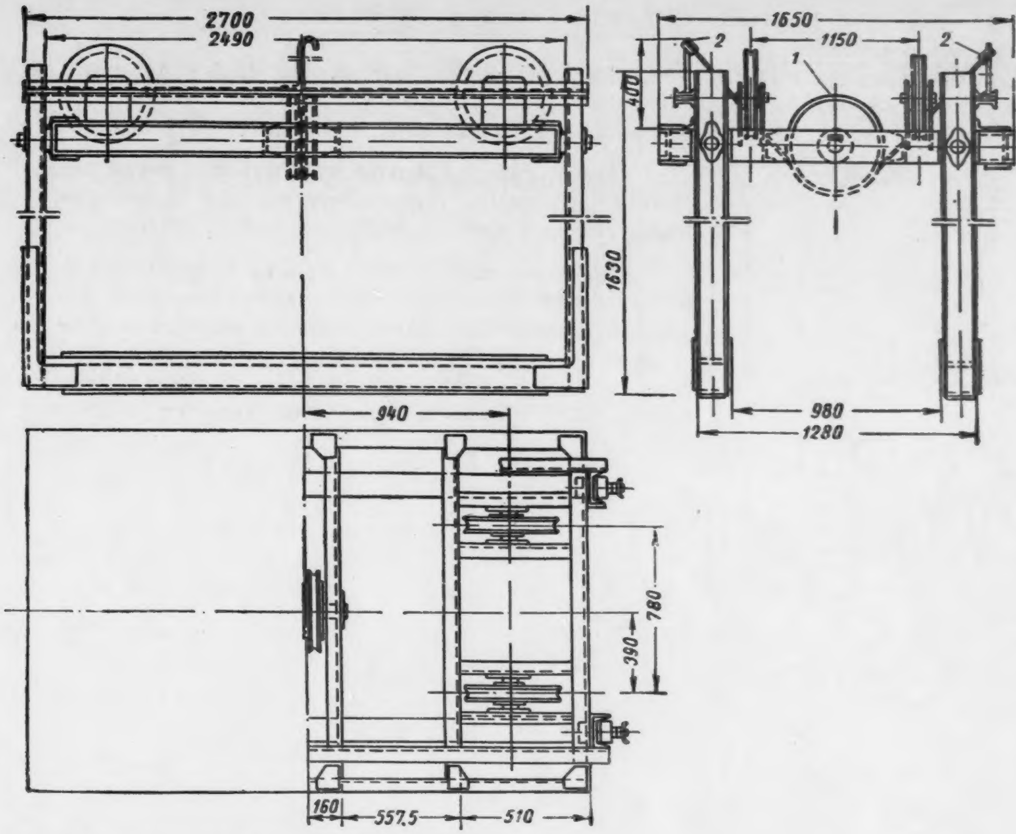


Fig. 9. Device for clamping molds. 1) Roller; 2) lever.

A Peephole for Access to the Throttle Valve in the Air Pipe. V. P. Emel'yanov

Magnitogorsk Metallurgical Combine

In the operation of open-hearth furnaces, especially after repairs, cases are found of wedging of the throttle valves in the air pipes near the framework of the regenerators.

To free the valves the ventilator has to be switched off and someone crawls through the disc valve inside the air pipe.

I. A. Demin has suggested fitting the air pipes near the throttle valves with peepholes with gate valves (Fig. 10). The use of peepholes means that if necessary the speed of regulation of the throttle valves can be doubled.

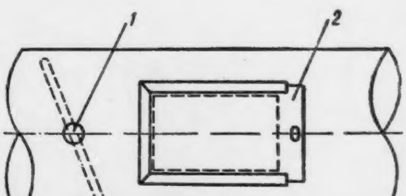


Fig. 10. Peephole in air pipe. 1) Throttle valve; 2) gate valve.

Increasing the Life of Crane Rails. V. P. Emel'yanov

Magnitogorsk Metallurgical Combine

The crane rails of the casting bay of an open-hearth furnace wear rapidly at the joints. In one year about 200 m of rails has been replaced in one open-hearth department alone.

To reduce repair work and to lower the consumption of rails at the Magnitogorsk Metallurgical Combine, I. S. Sidorenko has suggested electric building-up of rails at the points which are low. By building-up the life of rails has been increased 2-3-fold.

Changing the Design of a Mold for Taking Samples. V. P. Emel'yanov

Magnitogorsk Metallurgical Combine

To take metal samples from the molds in steel smelting departments they use round vessels with a tapered cavity into which the molten metal is freely poured and after it sets it can be readily knocked out. However , for chemical treatment and taking analyses the sample has been given a flat shape on forging hammers.

At the Magnitogorsk Metallurgical Combine to process the samples in the steel smelting departments there are five hammers, the loading of which did not exceed 5% of the working time.

N. V. Zaveryukha has suggested replacing the round vessels by composite molds forming an ingot of rectangular cross section (Fig. 11). The mold is assembled on a base of refractory metal and after the metal has set it is dismantled and the finished ingot is obtained. The introduction of the suggestion has considerably eased the work of steel smelters and has released the forging hammers for other production.

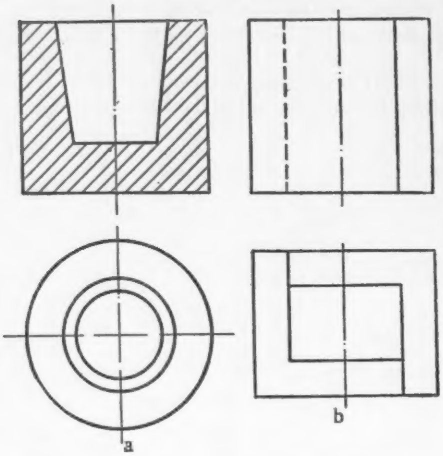


Fig. 11. Mold for taking samples: a) round ; b) split.

ELONGATION IN A RECTANGULAR PASS

I. P. Shulaev

Roller at the Magnitogorsk Metallurgical Combine
Translated from Metallurg, No. 5,
pp. 23-24, May, 1961

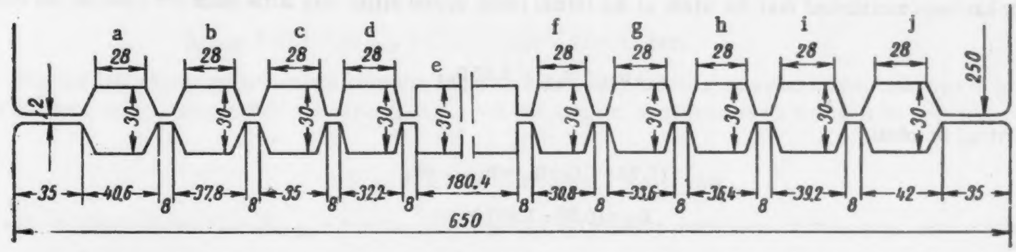
Rectangular passes–simple in shape–are widely used in roll-groove design. When rolling in them the shape of the pass has an important effect on the value of the forward flow and pressure of the metal on the rolls. Of considerable importance are selection of a rational shape of the rectangular pass, the value of its elongation, and also the correct choice of speeds during rolling in a continuous billet mill.

For this Magnitogorsk Metallurgical Combine studies have been made on the 250 laboratory mill. Lead was used as the material for the specimens.

The rolling was carried out on iron rolls in rectangular passes with elongations of 10-50% and on a smooth barrel (see figure).

Four series of specimens were rolled in each pass with different relative reductions: $\frac{\Delta h}{H} = 25$; 30 ; 35 ; 40% with a constant h = 30 mm.

The value of the forward flow was determined by the centerpunch method. On the bottom and side walls of the pass marks were made with a centerpunch. The rolling pressure was measured by two dynamometers with wire strain gages placed near the compression screws and records were made with an oscillograph.



Roll-groove design of a 250 laboratory mill; elongation, %: a) 45 ; b) 35 ; c) 25 ; d) 15 ; e) smooth barrel ; f) 10 ; g) 20 ; h) 30 ; i) 40 ; j) 50 .

On the basis of the obtained data it is possible to decide not only on the effect of the constraining action of the side walls of the pass on the values of forward flow and the pressure of the metal on the rolls, but also on the character of distribution of the forward flow over the perimeter of the rectangular pass. The maximum value of forward flow corresponds to the bottom of the pass; on its side walls on approaching the place of separation of the rolls the forward flow decreases frequently to a negative value. This indicates that at the points corresponding to negative forward flow there is slip of the side walls of the pass on the rolled strip.

The reason for this phenomenon is that the speed of exit of the strip from the rectangular pass is always constant and the peripheral speed of the rolls changes, increasing on approaching the place of separation of the rolls. This should presumably explain the uneven wear of the side walls of the passes in the form of a "Christmas tree".

With the reduction of the elongation of the pass to 10% (as shown by an investigation) the increase in forward flow at the pass reaches 70% compared with the forward flow on the smooth barrel. Under these conditions the pressure of metal on the rolls rises up to 20%. It is therefore not advisable to use small elongations of rectangular passes (6-12%) in those cases where it is not necessary since there is not only increased wear of the passes but also a

noticeable increase in the energy consumption. It is recommended, where possible, that rectangular passes should be used with elongations of 25-30%.

Operating experience in the rolling mills of the Magnitogorsk Metallurgical Combine shows that rolling in these passes proceeds stably and is accompanied by an improvement in the quality of the rolled stock (there is a reduction in rejects from "undercutting" due to the reduction in wear of the side walls of the pass).

To reduce the effect of the elongation of the pass and to obtain more stable speeds when rolling in continuous billet mills it is recommended that as large a number as possible of rectangular pass strands should be used with the same elongations.

POSSIBLE REDUCTIONS IN EDGING PASSES

N. V. Litovchenko

Magnitogorsk Mining and Metallurgical Institute
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pp. 24-25, May, 1961

Experience in rolling strip in all the mills of the Magnitogorsk Mining and Metallurgical Combine showed that the width of the final strip (finished profile) determines the width of the initial blank, and the total coefficient of height deformation determines its thickness. Allowance should be made for the number of edging passes included in the grooving system and the systems of reductions, or determined by the design of the mill.

It has been established that the width of the initial blank should differ very little from the width of the finished strip:

$$B_{bl} = b_{str} \pm 0.05 B_{bl}.$$

Simplifying, we obtain

$$(0.95 - 1.05)\, B_{bl} = b_{str} \quad \text{or}$$

$$B_{bl} = (0.95 - 1.05)\, b_{str}.$$

If we assume a coefficient of 0.95, then in the edging passes the value of the partial and total compressions will be somewhat less than in the case where a coefficient of 1.05 is taken.

The optimum width of the initial blank should be taken to be a value equal to the finished strip:

$$B_{bl} = b_{str}.$$

In this case the increase in width of the strip during rolling as a result of free expansion can be brought to the necessary decrease in reductions in the edging passes, within the limits of the possible value.

The absolute value of the reduction in the edging pass depends on the thickness of the strip. It should be remembered that the smaller the thickness and the greater the width of the strip the less it is necessary to assume values of particular reductions in the edging passes since otherwise it is possible to obtain a certain "grooviness" in the strip accompanied by a distortion in the shape of the edges. The phenomenon of "grooviness" is connected with very considerable reductions of wide and thin strip in the edging pass. On the other hand, the process of reduction of strip across the width in the edging pass should be related to the ordinary process of rolling high strips for which the presence of uneven deformation across the height of the strip is characteristic. The combination of uneven deformation across the height of the strip with the possible appearance of grooviness limits the value of reductions in the edging passes and makes it possible to recommend limiting values of absolute reductions in them:

a) $\Delta h_{edg.\,max} = (0.1 - 0.2)\, b_{str}$

when $\dfrac{H_{bl}}{B_{bl}} = \dfrac{h_x}{b_x} = 0.4\text{-}0.45;$

b) $\Delta h_{edg.max} = (0.02 - 0.03)\, b_{str}$

when $\dfrac{h_x}{b_x} = 0.015 - 0.025,$

when h_x and b_x are the thickness and width of the strip in any transition cross section.

As an example we will calculate the width of an initial blank and the permissible value of reduction in the edging pass when rolling strip of width b = 200 mm and thickness h = 3.5 mm on a 300 continuous strip mill, consisting of fourteen stands arranged in the following order: V-3H-V-2H-V-3H-V-2H, where V is a stand with vertical rolls and H is a stand with horizontal rolls.

In accordance with the practical coefficient of height deformation K_{tot} in stands with horizontal rolls we determine the height of the initial blank (K_{tot} = 24.25):

$$H_{bl} = K_{tot} \cdot h = 24.25 \cdot 3.5 = 85 \text{ mm}.$$

According to the above equation the width of the blank is

$$B_{bl} = (0.95\text{-}1.05)b_{str} = (0.95\text{-}1.05)200 = 190 - 210 \text{ mm}.$$

To provide better treatment of the edges it is recommended that a large width of the initial blank be taken so that correspondingly it would be possible to take greater values of reduction in the edging passes. In this case we assume B_{bl} = 210 mm.

For a strip mill in the first pass (first stand with vertical rolls) with a ratio $\frac{H_{bl}}{B_{bl}} = \frac{85}{210} = 0.405$ mm the reduction in the edging pass is

$$\Delta h_{edg} = (0.1\text{-}0.2)\, b_{str} = (0.1\text{-}0.2)210 = 21 - 42 \text{ mm}.$$

For the last edging reduction (the prefinish stand V) with a strip fed into the stand of thickness h_x = 5 mm, width b_x = 205 mm, and, correspondingly, a ratio $\frac{h_x}{b_x} = \frac{5}{205} = 0.024$ mm, the maximum reduction will be

$$\Delta h_{edg} = (0.02\text{-}0.03)205 = 4.1 - 6.15 \text{ mm}.$$

We will assume a mean value Δh_{edg} = 5 mm. The reduction systems are determined similarly for other mills.

SURFACE DEFECTS IN ROLLING

P. Ya. Ryzhkov and R. M. Shereshevskaya

Central Factory Laboratory, Petrovskii Factory

Translated from Metallurg, No.5, pp. 25-26, May, 1961

It is frequently very difficult to establish the cause of a particular defect in the surface of a rolled product. At the Petrovskii Plant to look into the nature of their formation an investigation has been carried out of surface defects artificially introduced into an ingot for a steel 3 sp tube billet*.

*A. D. Koshcheev, G. M. Katsnel'son, T. S. Rashba and others took part in the work.

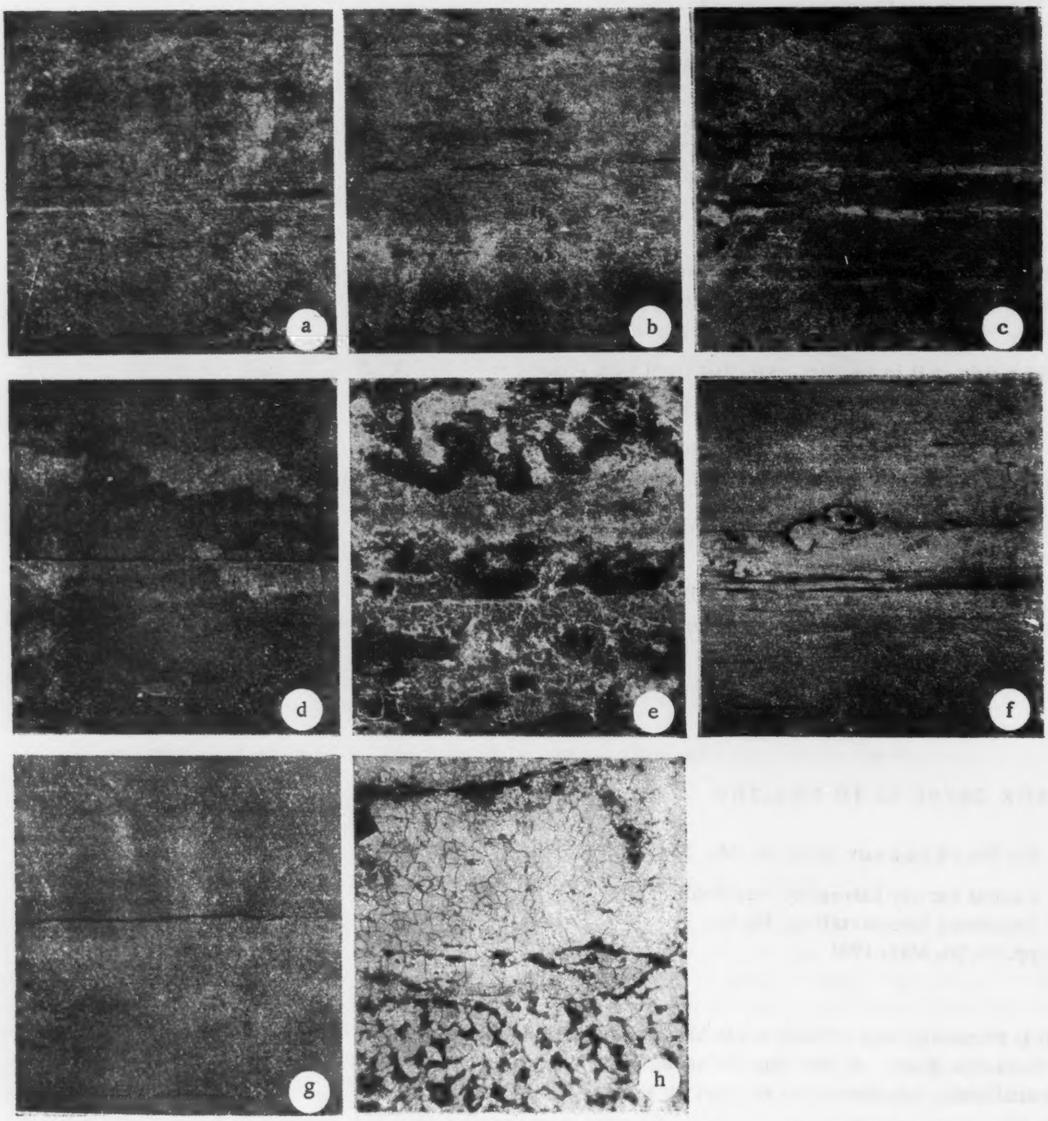
In the ingot, seven holes 16 mm in diam and each 60 mm deep were drilled. Six of the holes were filled with various substances (graphite, tar, firebrick, etc.), but the seventh hole remained empty. The hole filled with gray cast iron was closed with a piece of the same iron, but the remainder were closed by screwing in steel samples. Then the ingot was heated and rolled into a 90 mm diameter tube billet. Investigation of the billet surface after rolling showed how the appearance of the defect depended on the introduction of the following additions (in the figure the defect macrostructures are marked with the corresponding letter):

a) ferrophosphorus: clustered fine cracks up to 2 mm deep, decarburized at the ends;

b) graphite: cracks with jagged ends charging into a transverse crack;

c) ferrophosphorus and graphite together: cracks with jagged edges and fine clustered cracks;

d) cast iron: coarse cracks with jagged edges, charging into a scab;



Appearance of surface defects in the rolled product.

e) tar (grease): shallow transverse tears;

f) furnace scale: cracks with ends of various shapes, and also flat layers of metal of a different shape with enclosed or semi-enclosed contours; microexamination in the region of the defect showed a crack up to 3 mm deep, around which werestrong decarburization and a large amount of fine oxides;

g) fireclay: coarse open cracks.

In the position which had not been filled with additions, a defect was obtained in the form of a lap (h) with decarburized zones up to 2 mm deep and with fine oxides and inclusions of scale.

The investigation of artificially produced surface defects has made it possible to obtain for each of them a typical metallographic picture, which may be used in determining the nature of surface defects observed in the fabricated rolled product.

THE USE OF ROLLS BUILT UP BY WELDING

A. N. Nesmachnyi

Chief Foreman of Mill 2800, Voroshilov Factory

Translated from Metallurg, No. 5,
p. 27, May, 1961

To increase their service life, new working rolls, 1150 mm in diameter, of steel 60 KhN for a two-stand plate mill are being built up by the E. O. Paton method.

The roll, preliminarily heated in three inductors, used at first to be built up in a welding machine in two layers in one traverse with two A-384 apparatuses. The roll preheat temperature in the welding zone was held constant by means of a fourth inductor, which was set up on the machine in front of the welding apparatuses and moved with them.

To reduce the temperature fall along the length of the roll, and also to heat up more gradually, the inductors were switched off every 10-15 minutes and moved to a new region of the roll. After 5-10 minutes they were switched on again, and the preheating cycle was repeated. The preheat duration was 20 hours; the hardness of the layer deposited on the roll flank was 70-75 Shore units. Then the roll was heated to 370-380° C and cooled in 72 hours in a heat-retaining box. For welding, powder-wire PP3Kh2V8 and flux AN-20 were used.

When the rolls were used in the two-high stand, cracks appeared in the deposited layer, which spread deep into the roll body,and this led to its flank spalling. In 1958, seven rolls spalled and thus up to 30% of the deposited layer was eroded.

Analysis showed that a large part of the spalling was connected with thermal stresses appearing in the initial period of heating the rolls in the stand, and also with thermal stresses arising during the heating of the rolls in the inductors. The formation of internal cracks is accompanied by the typical crepitation of the roll in warming up. Moreover, cracks can be discovered in sounding the roll with a UZD-7N ultrasonic defectoscope.

In using the rolls it was clear that between the hard deposited layer of the roll and the soft base there is a transition zone, which has an increased hardness as compared with the roll.

At the present time, the comparatively small degree of wear of rolls in the deposited layer has made it possible to build them up in one layer. Thus the deposition time has been halved, the temperature regime has been improved and the amount of spalling has been reduced.

With a deposited layer 4 mm thick, a roll 1150 mm in diameter runs with an increased hardness up to a diameter of 1130 mm.

In order to get the roll temperature near to the working condition (60-80°C), in the factory they are preliminarily warmed up before installation in the stand in a special steam bath for 16 hours at a steam pressure of 5-6 atm. The direction of the steam jet should be such as to avoid its falling directly on the roll. Four hours before charging the rolls, they are removed from the bath and rolling is started at the normal speed for the mill.

Built-up rolls have a high surface wear resistance and can run without roll-changing for more than a month, but to prevent deep cracks the roughing stand rolls are changed every 7-10 days. All cracks visible to the naked eye are removed on a grinding machine, then the rolls are held in a warehouse ; this favors the relief of the stressed condition after rolling and raises their serviceability.

The improvement carried out in the deposition process and in the use of rolls in the roughing stand has made it possible to reduce the amount of roll spalling and to shorten time lost in roll-changing.

INCREASE IN PRODUCTION CAPACITY OF A WHEEL-ROLLING MILL

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The K. Liebknecht Plant's wheel-rolling mill is the only one of the units which produces deformation of the wheel billet in the preparation of seamless-rolled wheels. Frequently it holds up the production capacity of the entire press-rolling equipment.

The billet, obtained by sectioning complete ingots, is preheated to 1220-1240°C, and deformed in steam-hydraulic presses and in the wheel-rolling mill. In the steam-hydraulic press the upsetting of the billet is carried out with a force of 3000 tons and the upset billet is dished and the central hole is pierced ; this is used subsequently for centralization in the shaping press. Then on a 7000-ton steam-hydraulic press the wheel-billet is shaped, after which the rolling of the rim, the shaping of the web and of the rolling surface of the wheel are carried out in the wheel-rolling mill. Sizing the rim for width, and cambering the disk are executed in a 2500-ton steam-hydraulic press.

The billet shape is shown in the figure for rolling wheels 950-1050 mm in diameter after each operation has been carried out in the press and rolling equipment.

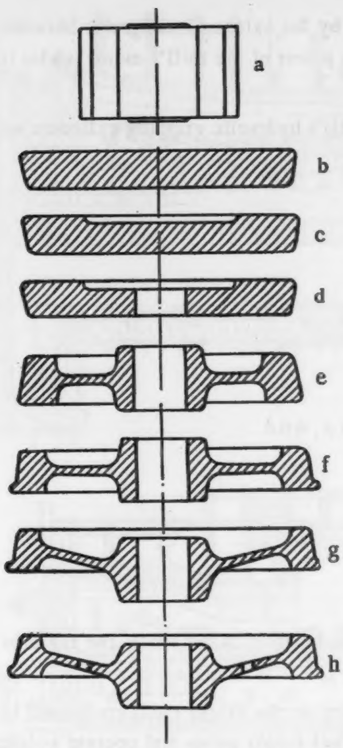
The wheel-rolling mill acts as a plant with discontinuous action. The billet enters from above ; to do this, the working stand is moved aside and guide rollers are set up. At the end of the process the finished wheel is raised and put to the side by a swing crane. Thereupon, the working stand is moved aside again and the guide rollers are set up.

Auxiliary and transport operations constitute a considerable part of the time taken in the whole rolling cycle. From the whole cycle of 34 sec, only 18 sec are taken in deformation (53% of the time).

Thus, one of the potential sources for increasing the production capacity of the wheel-rolling shop is to reduce the time taken in auxiliary operations. In connection with this, on the wheel-rolling installation at NTMK (Nizhnii Tagil' MetallurgicalCombine), entry and exit of the wheel billet from above have been replaced by its entry and exit from the side.

Calculations indicate that this measure will make it possible to reduce the rolling cycle time by 15-20%.

Investigation of diagrams of power expended by the wheel-rolling mill motors has made it possible to establish the presence of two characteristic periods in the rolling process. The preparation for rolling is carried out in the first period, and in the second the rolling itself. The preparation for rolling consists of the lowering of the upper inclined roll, the preliminary rolling of the rim until its width reaches the required dimension and of the subsequent change-over of the mill's clamping cylinders from low (60 atm) to high pressure (160 atm). It has been established that in the preparatory period as much time is used up as in the rolling, and sometimes even more.



Wheel-billet shape after b) upsetting in 3000-ton press ; c) pressing with the die in 3000-ton press ; d) broaching in the 3000-ton press ; e) shaping in the 7000-ton press ; f) rolling in the wheel-rolling mill ; g) cambering the disk in the 2500-ton press ; h) broaching the apertures in 315-ton press. (a) is the initial billet.

Such a time distribution is determined to a considerable degree by the mill control system used : control is accomplished by six distributors having 12 handles or knobs. The chief roller-operative should be able to open and close the distributor valves rapidly and successively. This is very strenuous physical and mental work, and besides this, it does not ensure the steadiness of the process even in working with any particular roller-operative.

The control system has therefore to be simplified so that it should promote a reduction of the machine time in rolling.

On a similar mill at NTMK the control system consists of five handles, and control by these considerably lightens the roller-operative's task, stabilizes the process and considerably reduces rolling time.

Reducing the number of control points at the NTMK mill was achieved by changing the mill's hydraulic system. At the K. Liebknecht Plant water at a pressure of 60 and 160 atm is used, and this is fed from separate pump-accumulator plants. The presence of two mains makes it necessary, in changing over the cylinders from low to high pressure, to close the valves joining the cylinders to the low pressure main and to open all the valves joining the cylinders to the high pressure main. In the subsequent change-over from high to low pressure, the valves are closed and opened in the reverse order.

In the NTMK scheme, water at a pressure only of 160 atm is used, which is fed from a pump-accumulator plant. To reduce the pressure to 60 atm an intensifier is used. The change-over is accomplished with only one small lever, and this considerably simplifies the control of the mill. The use of one hydraulic system instead of two reduces running costs and makes maintenance of the equipment easier.

Working with increased reductions is a considerable reserve for the growth of wheel-rolling mill productivity. Investigations which have been carried out have shown that, in rolling wheels with various reductions, the specific pressures on the inclined rolls vary in narrow limits, and that this arises chiefly from the differing temperature and from the different values of the resistance to deformation, which depend on the chemical composition of the wheel steel being rolled. One may consider that the specific pressures on the inclined rolls of a wheel-rolling mill do not depend on the value of the reduction. This extremely important conclusion indicates the unique character of the process of rolling wheels and makes it possible to clarify why it has been possible to achieve a considerable over-fulfillment of the planned production capacity without any essential technical improvements on the wheel-rolling installation at the K. Liebknecht Plant. As a result of the investigation carried out, a number of reductions and contact areas and their relative values were established (table).

Sets of Reductions and Contact Areas, and Their Relative Values

Reduction, mm	Contact area, mm^2	Relative value of reduction	Relative value of contact area
4.5	2237	1.00	1.00
4.8	2314	1.066	1.034
5.0	2363	1.11	1.056
5.37	2453	1.19	1.096
5.6	2540	1.24	1.135
6.0	2612	1.33	1.167
6.3	2705	1.395	1.209
6.6	2783	1.465	1.244
7.25	2913	1.61	1.302

From a comparison of the values set out in the table it is clear that an increase in relative reductions goes on more strongly than an increase in contact areas. Consequently, the specific pressures being independent of the reductions, working with large reductions will require a comparatively small increase in forces.

Roller-innovators have partly used this feature of the wheel-rolling mill and will be able to improve on the mill's planned production capacity by a factor of almost 2.5.

However, the reserves of production capacity are still not completely used, and this is confirmed by the

incomplete use of the power of the upper inclined roll clamping cylinder and by the existing incongruity between the powers of the slide cylinders and of the upper inclined roll cylinders. The power of the mill's motor is also inadequately used.

The best solution of the problem of making the optimum use of the mill's hydraulic gripping cylinders would be the automation of the rolling process.

THE CONVERSION OF REHEATING FURNACES FROM FUEL OIL TO NATURAL GAS

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Il'ich Plant
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Uneven and inadequate heating of ingots prior to the piercing mill causes bending of the shells and ruptures of the inside layers of metal, thus fostering formation of defects.

In the tube-rolling shop, the ingots, prior to piercing and subsequent rolling on the Pilger mills, are heated in two continuous reheating furnaces heated by fuel oil. The furnaces have two fuel supply zones and operate according to a three-zone schedule of heating. The fuel oil is fired by Shukhov nozzles and compressed air is used at a pressure of 4-5 atm (gage) as a sprayer.

These furnaces under the most favorable conditions had an output of 28-30 t/hr, which did not supply the mills with the necessary amount of metal and held down an increase in tube production. In addition, the quality of heating the ingots, especially for tubes with a nominal diameter of 12 inches, was poor, since the ingots were heated unevenly longitudinally and transversely.

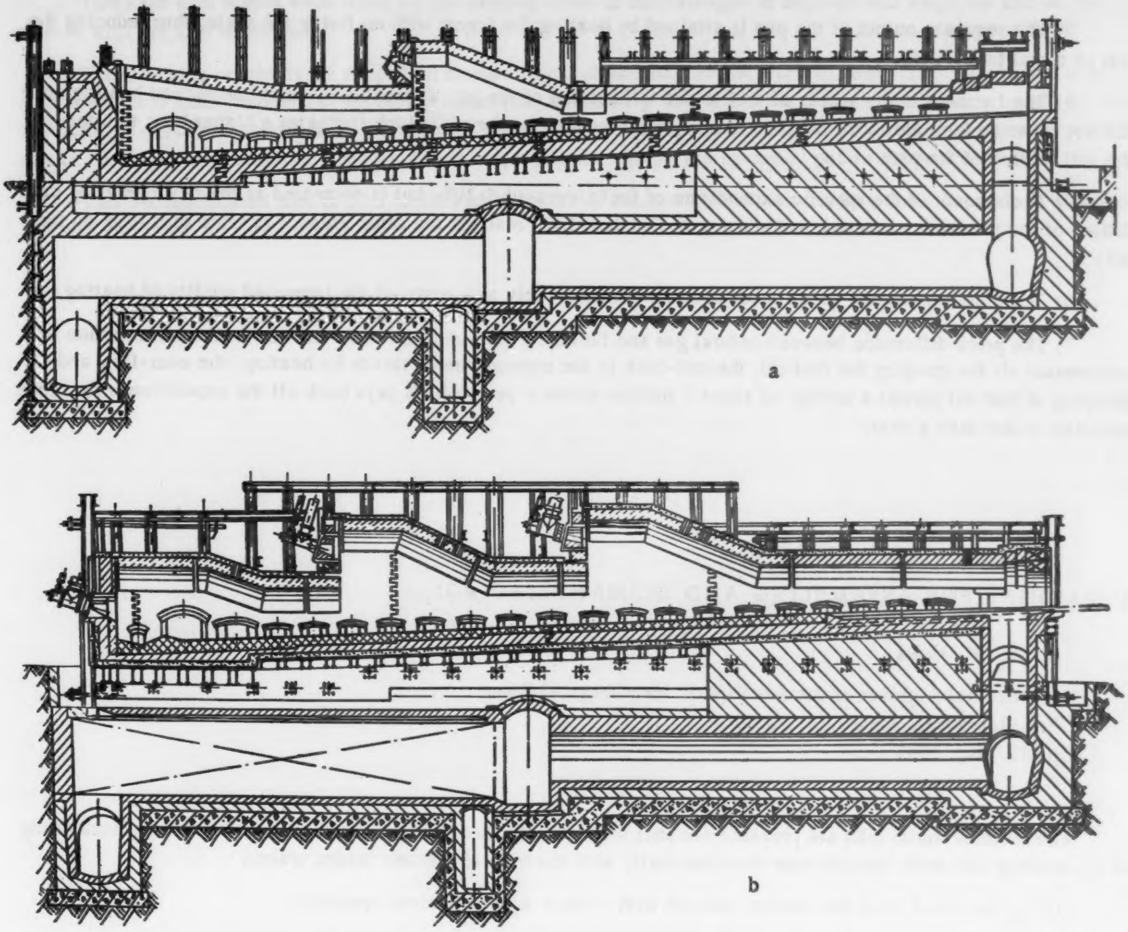
Attempts to force the heating conditions of the furnaces led to a still greater deterioration in the quality of heating and to a considerable increase in loss of metal, since the ingots fused in the soaking zone while heating. It is also necessary to bear in mind that the load on the motors of the piercing and Pilger mills increases at the same time the quality of heating the ingots decreases, as a result of which the number of breakdowns in the parts of the mills increases.

Operation of the furnaces with molten-slag tapping at high temperatures of the fuel oil flames favored a rapid increase in mounds on the bottom, which hampered turning and reduced the quality of heating the ingots. The inadequate purity of the fuel oil received by the plant and the impossibility of its fine filtration in the shop resulted in a partial clogging of the outlet openings of the nozzles, as a consequence of which the operation of the automatic heating control system of the furnaces was disrupted. The cost of heating was high, not only because of the high cost of fuel oil, but also because it was necessary to consume considerable quantities of compressed air and steam for spraying, preheating and transporting the fuel oil.

The furnaces were converted to natural gas at the time capital repairs were being made. Since it was not possible to change the dimensions of the furnace a second heating zone was constructed 12,700 mm from the tail of the pit and four "tube-in-tube" burners installed for heating. The fuel-oil nozzles were also replaced by burners of this type in the other zones.

As a result of the reconstruction the three-zone reheating furnace was converted to four-zone (figure).

The presence of the second heating zone considerably increased the transfer of heat to the surface of the ingots as a result of elevating the temperature of the furnace gases in that section of the furnace where the temperature of the metal is minimum, and the heat absorbing capacity is maximum.



Reheating furnace for ingots. a) Before reconstruction ; b) after reconstruction.

The increase in the number of fuel combustion zones along the length of the pit permits reheating the metal to the required temperature as it passes through the continuous and two heating zones, and thus in the soaking zone the temperature through the ingot section is only equalized. This operating method of the reheating furnaces makes it possible to increase the output of the furnaces, to increase appreciably the quality of heating the ingots, and to reduce the amount of metal loss without increasing the total consumption of fuel by more effectively redistributing it between the heating zones.

To increase the over-all strength of the reheating furnace structure, the elastic frames were replaced with rigid ones. The control and measuring system and the automatic machines were constructed in conformity with the change in the type of fuel.

The following conclusions can be made from the results of operating the reheating furnaces for five months on natural gas:

1) The output of the furnaces was increased and no longer limits the operation of the mills; when heating the furnaces with fuel oil, a considerable deterioration in the quality of heating the ingots occurred at a furnace output of 27-29 t/hr; now the quality of heating remains high at any output reached in practice (up to 35 t/hr);

2) The decrease in the difference of the temperatures of the surface and inside layers of metal of the ingots and the increase in the average temperature of the ingots led to a significant increase in the ductility of the metal, as a result of which the magnitude of the peak loads on the motor of the piercing mill was reduced by 10-20%;

3) The requisite output of the pits is attained by heating the ingots without fusing the scale, thus reducing the loss of metal by 20-25%;

4) The increase in the supply of fuel to the tail section of the pit attainable by using the second heating zone did not cause an increase in the temperature of the gases leaving the pit, which indicates a higher heat transfer in the tail section of the pit;

5) The amount of the specific expenditure of fuel increased 8-10%, but it decreased as the new operating conditions of the pits were mastered, and starting in October, 1960 reached the same amount as when operating on fuel oil;

6) The output of second-grade tubes decreased considerably as a result of the improved quality of heating;

7) The price difference between natural gas and fuel oil, the reduction of 40 m^3/min in the consumption of compressed air for spraying the fuel oil, the cut-back in the expenditure of steam for heating, the over-flow and pumping of fuel oil permit a saving of about 3 million rubles a year, which pays back all the expenditures for reconstruction in less than a year.

A MACHINE FOR ASSEMBLING AND DISMANTLING ROLLS

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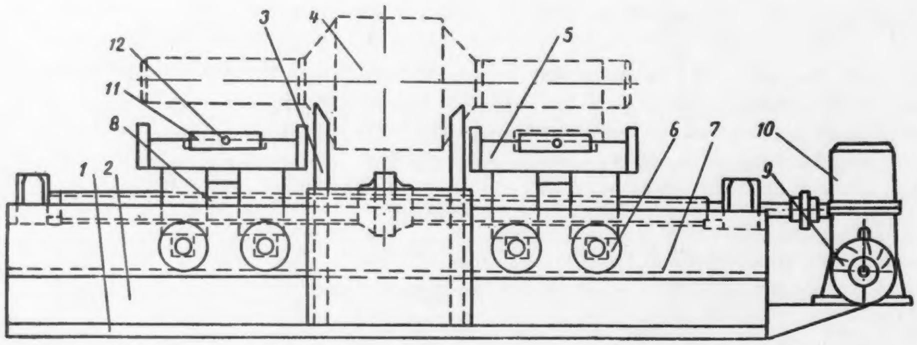
The sections where rolls are prepared are still inadequately mechanized. As a rule, assembly and dismantling of the working and back-up rolls were done manually with the help of electric bridge cranes.

Lifting the chuck from the neck of the roll with a crane was a laborious operation.



Machine for assembling and dismantling rolls. 1) Slab; 2) face; 3) bearing box; 4) working roll; 5) carriage; 6) wheel train; 7) guides; 8) screw pair; 9) electric motor; 10) reducing gear; 11) key; 12) screw.

A design is given below of a machine which has considerably facilitated the work and has increased the productivity of labor at the sections for the assembly and dismantling of the rolls (figure).

We welded on the 30-40 mm thick slab two faces-the housing of the mechanism, in the center of which was the bearing box with the working roll and the chucks mounted on it. The chucks of the working roll were placed on the moveable carriages that were moved by the wheel train along the guides by the screw pairs. The 10-kw electric motor drove the screw pairs through the worm reducing gear with a gear ratio of 8.

Two keys with screws were fixed on the working areas of the carriages to regulate and align the axis of the chucks with the axis of the roll.

This machine considerably simplified dismantling and assembly of the working rolls. The roll, tipped over with the chucks from the stand, is set by the crane into the bearing box, the drive of the screw pairs is turned on, and the carriage draws the chucks from the necks of the roll. Then the crane removes the old roll, and sets a prepared one in its place. The machine engages the carriages and the chucks are smoothly put on the new roll.

This uncomplicated mechanism facilitates the work of the machinist in assembling the rolls, and, in addition, releases the crane for other work.

In September-October, 1960, at the metallurgical plants of the Ukraine, an interplant school was conducted for the study of steel-pouring techniques and improvement of ingot quality. Representatives of plants and institutes participated.

STEEL POURING AT UKRAINIAN PLANTS

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Steel-Pouring Techniques

Killed sheet steel is poured at the Il'ich, Voroshilov and Zaporozhstal' plants. At the Zaporozhstal' plant, the steel is poured only from the top directly from the ladle through an unburnt magnesite-chromite stopper 30-35 mm in diameter in ingots of 11-16 tons with straight sides having a taper of 1.2-1.4% (wide sides) and not more than 0.83-0.85% (narrow sides). The temperature of the steel before tapping is 1575-1620°C, depending on the carbon content of the heat.

Pouring is commenced at half stream until a pool of liquid metal has formed on the stool, after which pouring is continued at full stream; then, on approaching the hot top, pouring is stopped for 10-20 sec, after which pouring is completed with diminished stream. The molds are coated at a temperature of 60-110° with a coal tar having a moisture content of not more than 0.5%.

Due to the extremely thick consistency of the coating material and the inadequate temperature of the molds, the ingots have a porous surface; the low rate of pouring promotes scab formation.

At the Il'ich plant, the metal for sheets is mainly top-poured through pouring boxes into ingots of 6-40 tons in weight. Some of the steel is bottom-poured into ingots weighing 2-6.7 tons. The molds are set on special supports on floating stools, so that the same mold can be used for pouring ingots of different weights. The cleaned and air-blown molds are coated at 80°C with dehydrated coal tar (moisture content not exceeding 1%). The pouring temperature of the steel is 1630-1650°C, independently of the weight of the ingot.

To eliminate lap in rolling the sheets, the narrow side of the ingot is semielliptical. To reduce stresses in the skin of the ingot and to increase its strength, molds recently designed at the plant have concave corrugations on the wide side. Sheet-steel ingots weighing 5-7 tons are being successfully poured in molds with shallow corrugations, without hot tops and with an enclosed shrinkage pipe.

At the Voroshilov plant, killed steel is bottom-poured in solid-end molds through a nozzle 40-45 mm in diameter into ingots 8.4-12.7 tons in weight. Unlike the other plants, the molds here have a taper of 3.4-3.8% on the wide sides and 2.2-3.8% on the narrow sides. About 40-50 tons of steel is poured on one stool.

A strict relationship must be maintained between the rate of pouring and the temperature of the liquid steel. Experience at the plant has shown that the rate of entry of the steel into the mold during pouring should gradually increase, i.e., the lower part of the ingot should be poured slowly (0.9-1.2 ton/min), while the upper part should be poured quickly (1.3-1.4 ton/min). With such pouring conditions, no crust or scabs are formed.

The school noted that the steel-pouring techniques adopted at the Voroshilov plant gave the least first-reduction discard.

According to the experience of this plant, it is advisable to ascertain the optimum tapping temperature of the steel and rate of pouring the latter.

To improve the measurement of the tapping temperature of the steel, the thermocouples must be graduated and mounted on light, convenient carriages of velocipede type. The quality of killed sheet-steel ingots will be better and the rate of pouring higher if the wide sides of the ingots are made concave. For 10-15 ton ingots, the concavity should not be less than 15-20 mm, the radius of the ingot edges should not exceed 10% of the mean dimension of the narrow side of the ingot. The taper of the wide sides should be not less than 2.5-3%. It is advisable to use solid-end ingots with corrugated sides.

For solving the problem of increasing the ingot weight, according to experience at the Il'ich plant, large ingots with corrugated sides must be produced, ensuring satisfactory quality of the surface of the sheets. It would be best to provide the facilities at one of the plants to carry out investigations on a wide scale to establish the temperature conditions and to select the optimum shape of the molds, semidry coatings, etc.

In top-pouring the use of unburnt chromite-magnesite nozzles should be avoided, and strictly vertical seating of magnesite nozzles should be ensured.

Rimmed steel is poured by almost all the metallurgical plants in the Ukraine.

At the "Zaporozhstal' " plant, for bottom-pouring of this steel, either two molds for large-weight ingots (13-18 tons) of sheet steel are set on one stool,or four molds for ingots of lesser weight. The metal is introduced into each mold through two orifices 60 mm in diameter. When pouring, the stopper is opened gradually, and for the first 40 to 70 sec, pouring proceeds with the stopper not fully open. The linear pouring speed is 0.2-0.45 m/min. If the metal is excessively over-heated, 50-100 g of granulated aluminum is introduced on to the surface of the metal when the mold has been completely filled. The temperature of the steel on tapping the furnace is 1600–1620°C ; a mold is filled in 5-10 min. The steel pouring nozzles have an orifice of 35-50 mm.

At the Voroshilov plant, rimmed steel is bottom-poured, a four-position stool being used. The pouring nozzle has a diameter 35-40 mm and that of the runners and end bricks, is 60 mm. The pouring rate is 0.2-0.285 m/min ; tapping temperature of the steel is 1590–1610°C.

At almost every plant, pouring of rimmed steel ingots is accompanied by the formation of a coarse slag crust on the exposed surface of the metal in the mold and high chemical inhomogeneity of the ingot. At the Voroshilov plant, for producing a homogeneous ingot, on completion of gas evolution, the ingots are treated with crushed ferrosilicon and a cap is put on the mold as soon as the metal begins to solidify. This technique has been found to give good results and is recommended for adoption at other plants.

At the Makeevka plant, rimmed steel is bottom-poured on eight-position stools in molds with corrugated sides (depth of corrugations 12-15 mm). Deflectors of roofing iron 3 mm thick are placed on the end nozzles to prevent scab formation.

At some plants, bottle-type molds are used, due to which discard is reduced.

The school advised all plants to cover rimmed steel ingots with caps of a thickness of not less than 100-120 mm of adequate weight, and dimensions 70 mm less than the corresponding dimensions of the top cross section of each type of mold.

For reducing the defects in the lower part of ingots, it is recommended that the period of reduced stream in pouring should be increased to 40-50 sec. For reducing chemical inhomogeneity of heavy ingots, the top part should be treated with ferrosilicon and the period of gas evolution of the steel in the molds should be reduced (in accordance with experience at the Voroshilov plant). To eliminate the formation of fissures in rimmed steel slabs, due to sweating of the ingots in the soaking pits, gas of high calorific value should be used for heating the pits so that a large number of burners can be installed and all-sided uniform heating of the ingots can be ensured.

In addition, the school considers it necessary to work out the optimum steel-pouring conditions in accordance with the sort of steel and the weight of the cast ingot ; to make additions of broken glass or slag fluidifying mixtures to the slag crust for eliminating rise in ingots ; to adopt ingots of considerable weight (18 tons) following the experience of the "Zaporozhstal' " plant ; to explore the possibility of top-pouring rimmed steel, to investigate the rapid pouring of rimmed steel through 75 and 100 mm diameter nozzles (according to experience of plants in the U. S. A.); to speed up the introduction of the technique of pouring rimmed steel in bottle-type molds (according to the experience of the Makeevka and Dzerzhinsk plants), as developed by the Dnepropetrovsk Metallurgical Institute.

In 1957-1960, attempts were made at the majority of the metallurgical plants of the Ukraine to produce semi-killed steel, which is extensively used in the national economy. Its advantages : high yield of serviceable material, low cost, satisfactory mechanical properties, simple manufacturing technique.

At the "Zaporozhstal' " plant, semi-killed steel is made according to two methods : a) Type St. 3 steel is deoxidized in the ladle with aluminum and 45% ferrosilicon, and is then bottom-poured into open molds; b) Type St. 3 steel and steel 08 deoxidized with granulated aluminum are bottom-poured and top-poured in open-ended molds. The yield of serviceable material when rolling semi-killed steel on the slab mill is as much as 90-91%, i. e., 2-3% more than for rimmed steel, and a better quality of product is obtained.

At the "Azovstal' " plant, semi-killed steel for pit props is deoxidized in the ladle only and with ferromanganese only. The use of this steel instead of killed steel results in a saving of 10-13% of steel, 4.9 kg/ton of 45% ferrosilicon and 300 g/ton of aluminum.

At the Il'ich plant, following the use of semi-killed steel, the liability of the ingots to cracks has been reduced considerably and the amount of rolling discard has been almost halved, compared with killed steel.

Killed steel for rolled section products is bottom-poured at all plants. At the Dzerzhinsk plant only, a small quantity of steel is top-poured. Big-end-up molds with hot tops and big-end-down molds (to some extent at the Makeevka plant) with standard hot tops are used. In the majority of cases the ingots are rectangular. At the Stalin plant, the steel is poured through 45-55 mm diameter nozzles, at the Dzerzhinsk plant, through 35-50 mm nozzles and at the Makeevka plant, through 40-45 mm nozzles. Temperature of steel before tapping: 1590 - 1650°C, depending on the sort.

Filling of the head portion of the ingot is advantageously done with a reduced continuous stream. Ingots with the best surface condition are produced by pouring the steel according to variable conditions, the bottom half of the ingot being poured with a reduced stream and the top half with the maximum permissible speed. The temperature of the steel when pouring should always be definitely related to the rate of pouring.

Open-hearth rail steel at the Ukrainian plants is mainly poured in ingots weighing 8.4-9.76 tons ("Azovstal' " plant) in round-bottomed molds. The molds are filled at full stream, the pouring rate being reduced toward the top of the mold. The proportion of rails affected by scabs, cracks and non-metallic inclusions is 3.56-5.96%.

To reduce crack formation on ingots, the school recommends that the curvature of mold sides be 8-10 mm, that the radius of curvature of the angles in the lower part of the ingot should be reduced to 65 mm, and that the quality of the coating on the bottom of the hot-top lining should be improved.

At the Dzerzhinsk plant, Bessemer rail steel is top-poured through intermediate ladles set on a special buggy. The Bessemer process for the production of rail steel is characterized by high output and simplicity of melting technique, while in addition it is much more economical than the open-hearth process.

At this plant, a new technique of blowing rail steel has been adopted, giving a reduction of nitrogen content, oxygen content and nonmetallic inclusions in the ingot.

Waste through flakes has practically been eliminated entirely by abolishing the spraying of molds with water.

In 1960, more than half the entire steel melted at the K. Liebknecht plant was cast in circular tubular molds by the bottom-pouring method. Deoxidation is carried out only in the furnace, either by means of blast-furnace ferrosilicon or ferromanganese. For this steel, the temperature conditions of melting are strictly regulated. Up to 60% of the discard in the round ingots is due to hot longitudinal cracks, 300 to 500 mm long and up to 3 mm in width.

Recently, deoxidation of the steel with ferroaluminum has been used, giving a cleaner surface and sounder ingots; in addition the aluminum consumption is reduced by 40%.

The school made a detailed study of the form of the head and bottom part of the ingot. It was found that transverse cracks in the bottom part of the ingot and increased tail discard are due to incorrect radii of the angles in the lower part of the ingot. Cracks are eliminated completely with a radius of curvature of the hemispherical part of the ingot of 500 mm, the tail discard then not exceeding 1.5%.

When casting rectangular ingots for sheet metal, the radius of curvature of their wide faces should be 380 mm and their narrow faces 880-900 mm. The transition to the hemispherical part of the ingot should be situated at a height of 350-370 mm.

Preparation and Utilization of Ladles

In recent years, in connection with the increase in the weight of heats, new ladles have been designed, of light construction but retaining the former rigidity and strength. Riveted ladles have been replaced by riveted and welded ladles and all-welded ladles. Full utilization of these ladles, however, involves reconstruction of typical ladle cranes.

To prevent slag from running over the edge of the ladle when tapping, it is preferable to widen the slag spout, making its side tangential to the circumference of the ladle.

Attention should be drawn to the experience of the "Azovstal' " plant in removing skull and scale soon after discharging the slag from the ladle, while the skull and scale are still hot. One or two holes, 200 to 300 mm in diameter, are burnt in them by means of long oxygen tubes, a special hook being introduced through the holes for removing the skull without damaging the lining of the ladle bottom.

Before being reconditioned, the ladles should be cooled by fan air. This considerably shortens the time of preparing the ladle and eases the working conditions of the laborers.

There is still a considerable loss of steel at plants due to burning through of stoppers and fracture of stopper heads. The stoppers should be made in special sections with mechanical feed of refractories and assembly of the final stopper.

The school noted many departures from the proper system of assembling and drying stoppers. Loose joints (up to 4 mm) are allowed at the Krivorog and Il'ich plants; thick stopper sleeves are not used at the Makeevka plant; the Dzerzhinsk plant uses unreliable fixing means for the stopper heads.

The best results are obtained when the final stopper is dried at 120°C for 48 hours. Reliable operation of the stopper during pouring is fully ensured by mounting it away from the edge of the ladle; the use of a wooden frame round the stopper head obviates sticking of the latter. The use of hollow, water-cooled stopper rods at the Stalin plant has considerably reduced the number of pouring failures and increased the life of the rods from 4-5 to 18-20 heats.

The school noted the unsatisfactory durability of steel ladles at plants of the Republic, which must be attributed to the absence of improvement in quality and operating characteristics of ladle stocks. Of the methods of lining employed, those of lining ladles at the "Zaporozhstal' " plant (thinnest) and at the Dzerzhinsk plant (spiral) are most deserving of attention.

At the Petrovsk and Krivorog plants, small capacity steel ladles are provided with a rammed working lining. The school recognized the need for improving the mechanization of the work of ladle lining and for arranging a centralized supply of plants with ladle stock.

The indisputable advantage of rammed tapping spouts (according to experience of the Dzerzhinsk and "Zaporozhstal' " plants) was noted.

Preparation of Mold Assemblies and Utilization of Molds

Currently, in high output open-hearth shops, the tendency is to organize a continuous assembling of molds. The most rational scheme of this kind has been devised at the Dzerzhinsk and "Zaporozhstal' " plants, where all assemblies of molds for rimmed and killed steel, after removal of the ingots, are sent in succession along one track of the mold yard. As the assemblies advance, the stools are cleaned, bottom-pouring runners are laid, and assemblies complete with molds are supplied in counterflow. With such a scheme, the crane equipment is well utilized and the output of the mold yard is increased.

The school recommends the following scheme for assembling a bottom-pouring stool. After cleaning the channels, fine, dry sand is scattered in them and is levelled by means of a templet. The runner bricks are then laid in them "dry", the joints being luted. The bricks are laid flush end to end so that there will be no escape of steel.

As a rule, the molds are cleaned manually at the plants. Mechanical cleaning of molds is employed only in the converter shop of the Krivorog plant. For coating the molds, either dehydrated coal tar or lacquer is used. A search should be made for new forms of coating which could be applied in thin layers, would be nonexplosive and free from harmful impurities, and would be simple and cheap to prepare.

To reduce mold consumption, it is essential to observe the correct conditions for their utilization, i.e., to cool hot molds in good time, to reduce the time of stay of the ingots in them, to repair them in good time, etc.

The school recommended an extensive application of semi-killed steel in the national economy, which will permit the rolling discard of steel to be halved compared with killed steel.

Unfortunately, the absence of a special standard specification and assessment for semi-killed steel is an obstacle to its more extensive use in industry.

The school recommends that the experience of the Dzerzhinsk and "Zaporozhstal' " plants in the use of bottle type molds be extended, as well as the experience of the Voroshilov plant in the use, on pouring, of an addition of

crushed 45-75% ferrosilicon of a size of 0-3 mm to the upper part of the rimmed steel ingots, the latter being covered at the same time by heavy caps. This improves the quality of the ingots and reduces top discard by 1-2%.

It is noted that top-pouring of killed steel at high pouring rates appears to be a promising method; plants should carry out extensive investigations in this direction.

In view of the fact that at some plants, departures are permitted from the established technique in regard to the temperature of the steel and the pouring rate, the school recommended that the pouring rate be defined precisely and regulated strictly in accordance with the sort of steel, ingot weight and steel temperature. It is essential to arrange for measurement of the steel temperature in the ladle.

To reduce top discard of killed steel ingots, the school recommends: a) replacement of mixtures of little effect of the "lunkerite" type by a coke -fireclay mixture or other thermally insulating mixtures; b) increase in the taper of ingot sides; c) use of hot tops with a form of inner cavity having a bottom cross section corresponding to the shape of the top cross section of the mold, and the top cross section round (elliptical); d) use of rammed lining instead of brick for the hot top; e) speeding up of researches on the use of exothermic heating and the use of lightweight and hollow bricks for the lining of hot tops.

For increasing still further the output of open-hearth shops and rolling mills, the school recommends speeding up of the change-over to large ingots of 20 tons or more and generalizing the experience on the design of ingots and molds with the object of developing the optimum parameters. In addition, the school considers it essential to produce new standard instructions on steel pouring, taking the advanced experience of the plants into account.

In view of the fact that the life of the steel-ladle lining at most plants of the Republic is unsatisfactory, the school considers it essential to instruct the Ukrainian Refractory Institute to continue the work on the life of ladle stocks.

It is proposed to introduce at the plants the highly-productive method of spiral laying of the working lining of ladles in accordance with the experience of the Dzerzhinsk and Stalin plants. For increasing the life of large capacity ladles, it is considered expedient to develop a uniform system of four-stage spiral lining. All plants are recommended to lay the brickwork of ladles on ready-prepared mortar, to mechanize the supply of mortar and to change over to the fitting of steel-pouring nozzles in standard ceramic ladle wells.

The school considers it essential to organize a centralized delivery of ladle and bottom-pouring supplies in containers, and to equip covered, mechanized stores of refractories at open-hearth shops.

Plants having ladles of capacities up to 50 tons should adopt the rammed lining of ladle walls following the experience of the Petrovsk and Krivorog plants.

With the object of reducing steel losses through break-away, it is recommended that shops pouring ingots of a weight of more than 8 tons use the bottom-pouring thick brick (120 x 120 mm).

The school considers it essential to mechanize the collection of refuse, stool cleaning and provision of bottom-pouring supplies, and to eliminate the manual preparation of mortars, etc. It recommends the organization of natural cooling of molds by spraying and the introduction of mechanized mold-cleaning installations.

To increase the throughput of pouring bays, the school recommends that a trial be made of double-stopper pouring at all plants where top-pouring is used; that the delivery of 200 and 230 ton steel-pouring cars be expedited to increase the number of large ingots cast on one car; that remote stopper control on the lines of that used at the "Azovstal'" plant be adopted; that high output plants change over to 16 m^3 slag pots; that the solution of the problem of weighing the metal in the ladle and program control of pouring be expedited, as well as the provision of walking cranes along the main row of columns.

LET US INTRODUCE ALL THAT IS VALUABLE AND ADVANCED

Ya. L. Granovskii

Central Committee of the All-Union Society of Inventors and Efficiency Experts
Translated from Metallurg, No. 5, pp. 36-37, May, 1961

From the working experience of the Technical Information Service of the Chusov Metallurgical Plant

Serious tasks now stand before the collective of the Chusov Metallurgical Plant: during the years of the Seven-Year Plan it must increase the output of pig iron by 80%, steel by 43%, rolled products by 35%; in addition, the innovators of the plant have pledged to contribute 6.4 million rubles to the Seven-Year Plan efficiency promotion fund.

The introduction of new techniques and advanced experience at the plant in many respects depends on the work of the Technical Information Service. The plant Department of Technical Information is intimately related with the primary organizations of the All-Union Society of Inventors and Efficiency Experts and the Scientific and Technical Society. Thus, a plan for propaganda, reviews of technical literature, and also the study and propagation of advanced industrial experience was compiled in 1960 together with the Scientific and Technical Society. This plan, which was approved by the director of the plant, was strictly controlled by E. I. Grishtel', Chief of the Department of Technical Information.

The plan called for reviews of newly issued technical literature, lectures by members of the Scientific and Technical Society and the most experienced engineers, as well as assignments at and excursions to related enterprises of the country.

The subjects of the schools of advanced experience (and last year there were more than 100 at the plant) were taken directly from the experience of the best producers. The schools were held in the shops where the most advanced labor methods are utilized.

We can cite numerous examples of the positive results from the extensive propaganda of the advanced experiences of the Chusov metallurgists.

In the repair department of the metallurgical shops, a brigade of eight men under the supervision of Comrade Gonkov bricked the main roof of the open-hearth furnace faster than another brigade consisting of 11 men. The Department of Technical Information propagated the experience of the work of these outstanding workers. The lagging brigade, having studied it, could soon cope with this work more quickly. Moreover, it reduced its staff to nine men.

A school for the exchange of experience of workers who run the presses was organized in the small-components shop. Innovator Bobkov demonstrated his working methods and taught them to the other workers of the shop. After this the productivity of labor in the shop increased by 7-8%.

The plant Department of Technical Information also uses in its work such mass media of propaganda as the local radio network. Radio broadcasts on materials of scientific and technical information are organized not less than once a month.

The widely circulated plant newspaper "Metallurg" does not lag behind this important and useful matter. Articles prepared by the department of information concerning advanced experience and new technical literature are regularly placed in the newspaper.

The Department of Technical Information regularly holds conferences on the generalization of the working experience of the best technical advisers. The manager of the shop usually participates in the work of these meetings.

The Department of Technical Information maintains constant communication with the Bureaus of Technical Information of related enterprises, and on their request sends its technical information material. For example, materials in response to a hundred requests from various metallurgical enterprises of the country were sent out last year.

In its turn, a number of technical innovations published in the express-information bulletins of the Perm Sovkhoz were introduced at the Chusov Metallurgical Plant in 1960. This saved the plant about 80-100,000 rubles.

Somewhat worse is the matter of selecting and introducing inventions the description of which is published in the technical information literature. This work in general was not done last year, and this year it is only noted to do this.

The plant social organizations (the All-Union Society of Inventors and Efficiency Experts and the Scientific and Technical Society) do not follow up the introduction of innovations published in articles of technical information. And this is all the more necessary since the material selected for introduction at the plant is usually not included in the plan of new techniques or in the plan for organizational and technical measures.

Unfortunately, the management of the plant did not give the Department of Information a room suitable for work (the department is cooped up in one small room where it is impossible to arrange the technical information material that is coming in); the technical adviser who arrived here to become acquainted with the newly received materials hardly had room to stand while selecting the needed literature.

To introduce the latest achievements of science and technology is a task to which the entire work of the Technical Information Service is subordinated, and the administration of the plant, along with the social organizations, should help this in every way possible.

A CONTRIBUTION OF THE EFFICIENCY EXPERTS OF THE "ÉLEKTROSTAL'" PLANT

F. Stadnik

Translated from Metallurg, No. 5,
pp. 37-38, May, 1961

The collective of the "Élektrostal'" Plant produces thousands of tons of steel and finished products over the plan annually.

In many respects these achievements depend on the work of the inventors and efficiency experts. Their creative initiative fosters the most rapid solution of problems of mechanization and automation of the productive processes, the modernization of equipment, the improvement of technology, the improvement in the quality of the products and decrease in their cost, a savings in metal, alloying elements, power, refractories, and other materials and also an increase in the culture of production.

Our efficiency experts, using internal resources, frequently solve complex technical problems rapidly and independently by simple means.

The number of efficiency experts at our plant grows with each year: in 1950 there were 775 of them in all, and by 1960 there were already 1590 or almost every fifth worker is an efficiency expert. Many of them, without discontinuing work, study in schools, technical schools, and institutes; 38 of the inventors of our plant received 52 patents for their inventions. Among them are Ya. S. Leizerov, chief of the No. 1 electric steelmaking shop; V. A. Bogdanov, deputy chief of the shop; senior foreman I. P. Solodokhin; and many engineers, technicians, and workers.

Such inventors as P. A. Potepalov, electrician of the No. 2 rolling department; V. N. Butskii, chief of the department; A. M. Artamonov and V. G. Pereverzev, workers of the Instrument and Control Department; A. F. Kablukovskii, deputy chief engineer; M. Ya. Dzugutov and A. P. Boyarinova, engineers of the Central Instrument Laboratory; and V. S. Kultygin each have two or more patents.

All this testifies to the fact that our efficiency experts and inventors not only improve the existing techniques and technology but also create those that are completely new, thus contributing their able share to the general affair of developing Soviet science and technology.

Workers of the plant P. Potepalov, I. Usik, N. Gusev, and V. Pereverzev invented emery roughing machines for the continuous bright turning of round sections of steel. The introduction of this invention made it possible to mechanize this laborious manual operation and to increase considerably the output of bright products. The annual saving on one lathe is more than 15,000 rubles. Five such lathes are now operating.

The use of refractory high-aluminous concrete for insulation of the coolers in the roofs of the electric-arc furnaces (the suggestion of A. Kabulkovskii, S. Skorokhod, and others) prevented burning through the coolers in the roofs of the electric furnaces, thus lowering the amount of metal rejects because of this and saved about 10,000 rubles a year.

The new design of a short network for the electric-arc furnaces that was suggested by A. Martynushkin, V. Tsukanov, Ya. Gancho, I. Shikov, and others, produced a considerable decrease in the power consumption and an increase in smelting.

The activity of the efficiency experts of the plant grows with each year. In 1950, 799 suggestions were submitted and in 1960, 2021. The introduction of 1240 suggestions alone saved about half million rubles a year. Due to the introduction of inventions and the suggestions for better production methods during the first two years of the Seven-Year Plan, we saved 1360 tons of metal, 546 tons of fuel, 2,830,000 kw-hr of power, 460 tons of refractories, and many other auxiliary materials.

The new legislation on inventions and innovations has broadened the rights of the engineers to receive compensation for their suggestions for better efficiency, and this has a positive effect on the results of the work. Almost every other engineer submitted a suggestion in 1960, and the annual savings from the suggestions used were more than 300,000 rubles.

In 1960 the plant counted 42 brigades combining 180 efficiency experts who developed and introduced many valuable suggestions and inventions. This form of activity for improved efficiency is very effective. Composite brigades for the introduction of suggestions for better efficiency have been organized and are active at a number of plants.

The band machine for electrolytically-assisted cutting of metal that was suggested by V. Butskii, Ya. Gancho, G. Korolev, and A. Artamonov is widely used not only at the "Élektrostal'" Plant but also at other enterprises. Whereas longitudinal cutting of ingots previously took several shifts of laborious work, now with the introduction of these machines it is done in several hours. The annual saving for one of these machines is 17,000 rubles. On the suggestion of these authors, with the participation of A. Bedovyi and V. Pereverzev, a machine for the continuous emery cleaning of billets was manufactured and put into use, and this permitted a considerable decrease in manual work. On the suggestion of B. Peshakov, K. Starkov, P. Potepalov and A. Izotov, a production line was set up for the welding and iron-electro-plating of thermostatic bi-metal, thanks to which the productivity in this section increased by more than 25%.

One worker has been freed per shift and manual labor considerably lightened in the section where the machine suggested by B. Peshakov for stamping sheets on the Lauth mill is used.

The unit for the electrolytic polishing of microwire suggested by P. Potepalov and N. Gusev is being used successfully. This increased the output of products and decreased the consumption of diamond draw plates.

The method of rolling certain steels in one reduction on the 600-mill that was suggested by engineers G. Shapiro and A. Birman produces an annual saving of more than 42,000 rubles. The device suggested by N. Krolikov for marking thermostatic bi-metal on the control and measuring machine made it possible to mechanize this manual operation and to release a worker in this section. Efficiency experts V. Rubtsov, A. Baluev, A. Poznyakov and M. Kokunov suggested mechanizing the operation of the charging-buggy clamps at the charging yard of No. 2 steelmaking shop. An electromechanical grab bucket for loading and unloading nonmagnetic shavings has already been manufactured and is being used.

These operations were previously accomplished by hand. In the same shop, on the suggestion of M. Akulovich, a new method is being used for laying the refractory funnels in the aligning apparatus by using wooden wedges when assembling the troughs; a new method was developed for sounding large billets for disks, by emery grinding flattened spots instead of snagging the entire billet, which saves more than 23,000 rubles a year (B. Lyubinskii, V. Stepanov, and I. Kutlinskii were the authors of this suggestion). In the ironworks department, the hopper distribution of the constituents for the molds was automated according to the suggestion of A. Pyatanin and F. Karamov. Workers of the plant K. Nikolaev, V. Monakhov, and T. Zuev suggested using water cooled flexible cables of the short network for the electric-arc furnaces, which saved the state 8,000 rubles a year. A. Artamonov and R. Arzamastseva by using a sus-

pended pneumatic pusher mechanized the means of delivering the ingots of high-speed steel to the reheating furnaces of the 600-mill for preheating, thus eliminating this heavy manual operation.

An easing of manual labor and increase in productivity are provided by the machine for turning the coils of strip when winding them like fabric. This machine was designed by K. Starkov and A. Martynov. In the No. 2 forge shop the delivery of billets and ingots to the box furnaces for reheating was mechanized according to the suggestion of M. Arapov. This now is accomplished by a moving ground-type pusher of simple design.

Many other valuable suggestions for improved efficiency that help to fulfill the state Plan have been and are being introduced at the plant.

NEW BOOKS

Treatment of Steel, by D. M. Kemp and K. B. Francis

Moscow, Metallurgizdat (Translation from English), 707 pp., 1960.

Translated from Metallurg, No. 5,
p. 38, May, 1961

This book, which is in a popular form, is devoted to the production of steel, rolled products, tubes, and small components in the USA according to the conditions existing around 1955-1956 and also describes the equipment used for these purposes.

Individual chapters of the book are devoted to heat treatment and quality control of rolled goods; considerable attention is devoted to the production of flat rolled products, especially sheets, tin plate, and also to welded tubes; modern methods of testing treated steel are examined in detail; different systems of roll passes are cited; the production of rolling-mill rolls is considered; methods of protecting the steel from corrosion are described.

The book is intended for metallurgical and mechanical engineers and also is of benefit to students in institutes of higher education and experienced manufacturers.

The book is well illustrated with photographs and diagrams.

[An article – The Tenth Session of the Administrative Committee of the International Union of Trade Unions and Workers in the Metallurgical and Machine-Building Industries (pp. 39-40 in the original) – has here been omitted from the translation, since it contains no information of a scientific or technical nature – Publisher.]

NEW BOOKS

Finishing and Threading of Pipes, by N. B. Rozenfel'd and P. A. Nabatov

Moscow, Metallurgizdat, 234 pp., 1960.

Translated from Metallurg, No. 5,
p. 40, May, 1961

This book is intended as a manual for training qualified workers in the pipe industry. It describes simply and in detail the technological processes of finishing and threading of all types of pipes; technical characteristics of the equipment being used and a brief description of it are given.

Considerable attention is devoted to practical methods in the work, selection, and adjustment of the tools. A method for circulating the throughput of the units and the working norms, and the most advanced operating and labor methods are examined. The basic methods of pipe production and the classification of threads are given.

The book is well illustrated with simple diagrams, sketches, and tables.

SIGNIFICANCE OF ABBREVIATIONS MOST FREQUENTLY ENCOUNTERED IN SOVIET PERIODICALS

FIAN	Phys. Inst. Acad. Sci. USSR.
GDI	Water Power Inst.
GITI	State Sci.-Tech. Press
GITTL	State Tech. and Theor. Lit. Press
GONTI	State United Sci.-Tech. Press
Gosénergoizdat	State Power Engr. Press
Goskhimizdat	State Chem. Press
GOST	All-Union State Standard
GTTI	State Tech. and Theor. Lit. Press
IL	Foreign Lit. Press
ISN (Izd. Sov. Nauk)	Soviet Science Press
Izd. AN SSSR	Acad. Sci. USSR Press
Izd. MGU	Moscow State Univ. Press
LÉIIZhT	Leningrad Power Inst. of Railroad Engineering
LÉT	Leningrad Elec. Engr. School
LÉTI	Leningrad Electrotechnical Inst.
LÉTIIZhT	Leningrad Electrical Engineering Research Inst. of Railroad Engr.
Mashgiz	State Sci.-Tech. Press for Machine Construction Lit.
MÉP	Ministry of Electrotechnical Industry
MÉS	Ministry of Electrical Power Plants
MÉSÉP	Ministry of Electrical Power Plants and the Electrical Industry
MGU	Moscow State Univ.
MKhTi	Moscow Inst. Chem. Tech.
MOPI	Moscow Regional Pedagogical Inst.
MSP	Ministry of Industrial Construction
NII ZVUKSZAPIOI	Scientific Research Inst. of Sound Recording
NIKFI	Sci. Inst. of Modern Motion Picture Photography
ONTI	United Sci.-Tech. Press
OTI	Division of Technical Information
OTN	Div. Tech. Sci.
Stroiizdat	Construction Press
TOÉ	Association of Power Engineers
TsKTI	Central Research Inst. for Boilers and Turbines
TsNIÉL	Central Scientific Research Elec. Engr. Lab.
TsNIÉL-MÉS	Central Scientific Research Elec. Engr. Lab.-Ministry of Electric Power Plants
TsVTI	Central Office of Economic Information
UF	Ural Branch
VIÉSKh	All-Union Inst. of Rural Elec. Power Stations
VNIIM	All-Union Scientific Research Inst. of Meteorology
VNIIZhDT	All-Union Scientific Research Inst. of Railroad Engineering
VTI	All-Union Thermotech. Inst.
VZÉI	All-Union Power Correspondence Inst.

Note: Abbreviations not on this list and not explained in the translation have been transliterated, no further information about their significance being available to us – Publisher.